PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

NOVEMBER 1957

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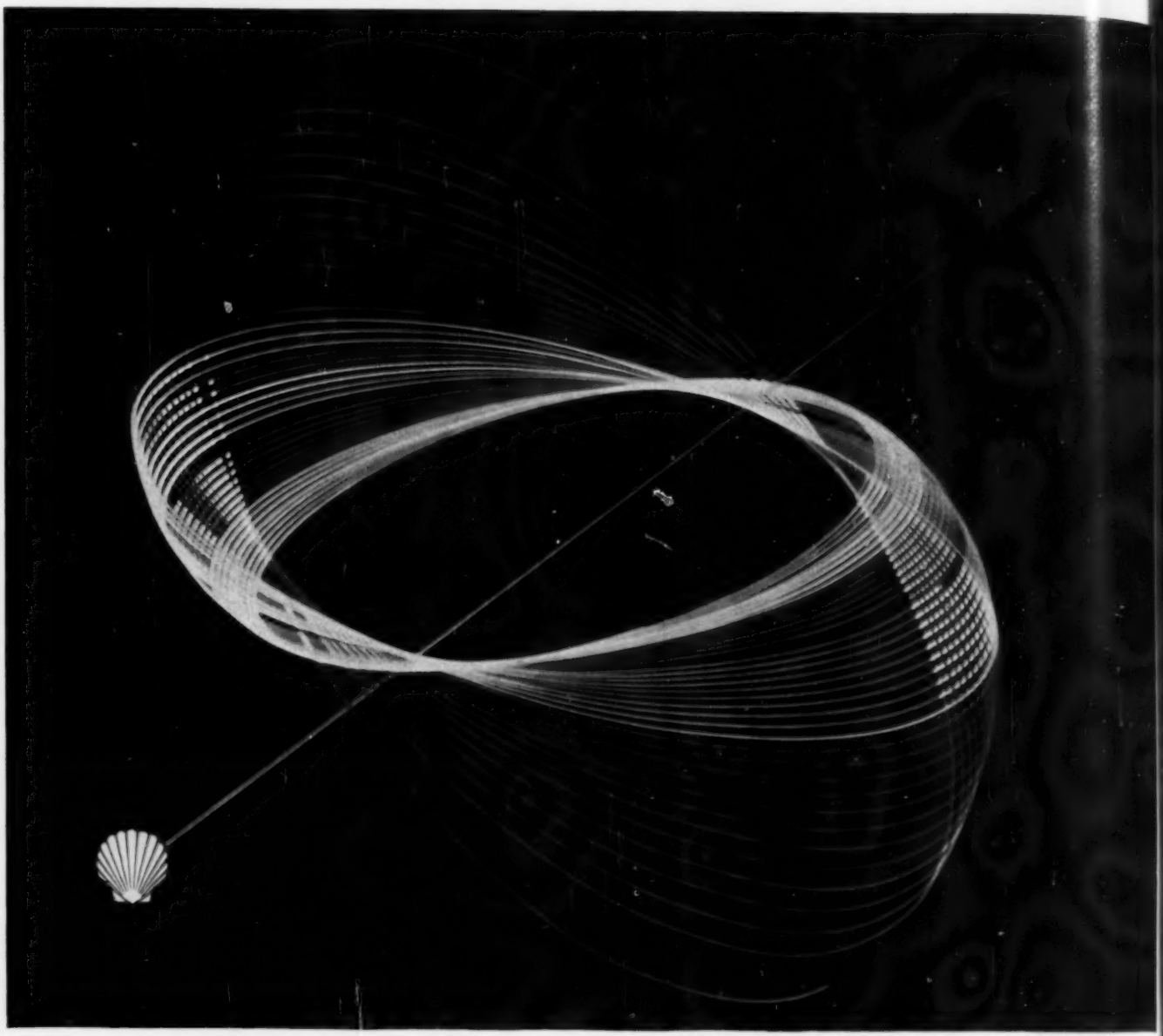
FORTY-FOOT SLOOP FEATURES A HULL OF GLASS-REINFORCED POLYESTERS

See article by R. J. Della Rocca/page 904

A BILL BROTHERS PUBLICATION



"Cyclic Planning," an impression by Max Richter

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PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

NOVEMBER 1957 VOLUME III NUMBER 11

ARTICLE HIGHLIGHTS and PREVIEWS 860

CAUSES AND CONTROL OF CALENDER ROLL PLATING OF VINYL COMPOUNDS ..... L. G. Howard & R. C. Hess 887

Results of an investigation of the plating effects of barium-cadmium stabilizers, chelating agents, pigments, resins, scrubbers, and stearic acid.

CYCOLAC IN RIGID THERMOPLASTIC PIPING .... H. H. Irvin & R. K. Multer 892

The strength properties, service conditions, installation, and handling of the material are discussed, together with its place in the over-all cost picture for piping.

STAGE LIGHTING CONTROL SYSTEM 898

GUEST EDITORIAL:

THE COMPRESSION FIELD ..... N. W. Oberle 899

HIGH-SPEED TENSILE TESTS OF THERMOPLASTICS ..... R. E. Ely 900

Exhaustive tests on polymethyl methacrylate and cellulose acetate-butyrate indicate that tensile properties are functions of time over wide ranges of test conditions.

REINFORCED PLASTICS IN BOAT HULL CONSTRUCTION—PART I ..... R. J. Della Rocca 904

Glass-reinforced polyesters are shown to meet the design and strength requirements for successful boat construction.

SOLVES ICE-LOCKING PROBLEM 911

REINFORCED PLASTIC PATROL BOAT 912

PLASTICS TECHNOLOGY ENGINEERING FORUM:

MOLDMAKING & TOOLING ..... Ernest J. Csaszar 913

REINFORCED PLASTICS ..... Harry T. Douglas 914

COMPRESSION & TRANSFER MOLDING ..... John H. Woodruff 915

FEATURE DEPARTMENTS

Letters to the Editor	860	New Materials	928
News in Brief	863	New Equipment	930
Editorial	873	New Products	932
News of the Societies	916	New Literature	935
Calendar of Coming Events	942	Book Reviews	936
News of Industry	918	Abstracts of Important Articles	937
News from Abroad	926	Patent Digest	939
Names in the News	922	Resins: Production & Sales	943
Quote . . . Unquote	868	Current Market Prices	945

Obituary 924

Cover photo courtesy: Owens-Corning Fiberglas Corp.

PUBLISHED MONTHLY BY

Plastics Technology Publishing Corp., a Division of

BILL BROTHERS PUBLISHING CORPORATION

386 FOURTH AVENUE, NEW YORK 16, N. Y.

The opinions expressed by our contributors do not necessarily reflect those of our editors

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BILL BROTHERS PUBLICATIONS

Article

Highlights

Causes and Control of Calender Roll Plating of Vinyl Compounds. (p. 887)
Test results show that plating in most cases is directly proportional to the concentration of basium-cadmium stabilizer used in the composition. Chelating agents used in high quantities, fillers, and stearic acid can reduce plating significantly, but pigments such as lead chromates and the phthalocyanines increase the amount of roll plating.

•

Cycolac in Rigid Thermoplastic Piping. (p. 892)
The four chief advantages of the plastic piping are shown to be permanence, lower material and installation costs (than most other piping materials), and smoother interior surfaces than steel piping.

•

High-Speed Tensile Tests of Thermoplastics. (p. 900)
High-speed test results on cellulose acetate butyrate and polymethyl methacrylate are reported, as obtained by means of a high-speed tensile machine and a standard Instron testing machine. The test results illustrate the complex time dependence nature of plastics.

•

Reinforced Plastics in Boat Hull Construction—Part I. (p. 904)
In this first half of a two-part article, the design requirements for boat construction materials are discussed. Fiber glass reinforced polyester is shown to be the most suitable material on the basis of its properties. Extensive data are given on laminate properties for boat hulls.

Previews

The following articles will be published in the December issue:

Design of Molds for Reinforced Plastics. John C. Reib, vice president, Shaw Industries, Inc., Franklin, Pa.

Hidden Injection Molding Costs. D. A. Dearle, plastics division mgr., North & Judd Mfg. Co., New Britain, Conn.

Adhesive Bonding of Polyethylene. W. H. Schrader, chemist, and M. J. Bodnar, chem. engr., Plastics Research Section, Picatinny Arsenal, Dover, N. J.

Reinforced Plastics in Boat Hull Construction—Part II. R. J. Della Rocca, asst. engr., design development, Gibbs & Cox, Inc., New York, N. Y.

The Guest Editorial will be **"Better Performance—The Way Out of the Polyester Squeeze"** by W. E. Wirsch, mgr. of polyester sales, Rohm & Haas Co., Phila., Pa.

Letters to the Editor

Thermal Control Material Wanted

Dear Sir:

The writer intends to manufacture a new product that will require an automatic, cold to hot air dry thermostat or a thermo control of some kind. Would like to have something with a half-inch expansion and a good thrust.

Is there a rubber or plastic material that will contract and expand with temperature changes? Can a soft Durometer rubber or plastic be compounded to do the work? Seems I have read of something along this line.

What material can you advise? Can you also refer me to several good sources who might be helpful?

Clem Ernst
Sidney, Ohio

(Can our readers offer any assistance in this matter, either directly or for transmittal to Mr. Ernst?—Editor)

• • •

Suggests Plastics Application

Dear Sir:

Apart from the requirements of this City's medical institutions, there is a vast demand by hospitals throughout the country for a waste receptacle of 12-, 16-, and 20-quart capacity, with a step-on opening mechanism. It should be capable of withstanding autoclaving at 250° F., at 15 psi., for 30 minutes. It could be made of linear polyethylene, nylon, or some other corosion-resistant plastic.

The waste receptacle we are seeking should be available at a price somewhat below those presently marketed in stainless steel, A.I.S.I. Grade 430. I have been unsuccessful in my efforts to find a manufacturer of such an item and thought that either you or your readers might guide me.

(Name Withheld)

(Any answers to this letter will be referred to the writer, who must withhold his identity in print due to policy requirements.—Editor)

• • •

Wants Stress on Fabrication

Dear Sir:

I would like more stress on all phases of plastics fabrication—laminating, resins, and adhesives. The field of fabrication is large and needs technical advice. Most fabricators have had to develop their own equipment and processes by trial and error which has been costly, with very little exchange of ideas or outside technical help.

A "clearing house" of information would be a "shot in the arm" for fabricators. Sheet, rod and tube manufacturers of various plastic materials have done an excellent job of selling, but have been lax on advice and have left the fabricators more or less out on a limb to develop their own devices and methods.

Experimental duplication of efforts on the part of all fabricators has proved costly and has been reflected in increased costs to the customer who has had to foot the bill for all this trial-and-error work.

Fortunately, fabricators on the whole have been very resourceful when challenged by an "impossible" job. Those less resourceful are out of business now or are barely making ends meet.

G. E. LaCaven, Owner
Kenmore Laboratories,
Buffalo, N. Y.

(Would our readership like to have us publish good articles on fabrication techniques, if obtainable? If desired, we'll be glad to try to obtain them, and your replies will provide ammunition for our quest.—Editor)

• • •

Wants Low Friction Plastics

Dear Sir:

Please inform me for research purposes which types of plastics are to be chosen when the least friction with iron or steel is desired. Also, where can these plastics be obtained?

Leslie Balany
Chicago, Ill.

(Any helpful suggestions from our readers will be transmitted to Mr. Balany.—Editor)

NEWS in BRIEF

A million-dollar PVC resin plant has been opened by Cary Chemicals, Inc., in Flemington, N. J. The facility has a capacity of 12-million pounds annually, but is so designed that production can be doubled or tripled without difficulty. Cary will employ a polymerization process developed by Scientific Design Co., which is said to produce resins with outstanding electrical properties.

Compression molding is not dead or dyeing, according to N. W. Oberle, sales manager of Baker Brothers' plastic press division. Although a plateau has been reached, there are new developments in the field. These include: faster-cycling automatic presses, heavier-tonnage presses, preheaters for automatic feeding, and automatic granulations of materials. (See guest editorial, page 899).

Company developments in the plastics industry saw the newly-formed Mimosa Corp. acquire Hoosier Cardinal Corp.'s Cardinal division. They will continue in the custom injection molding field. Witco Chemical Co. has formed a Canadian subsidiary for the manufacture and sale of industrial chemicals to the plastics, rubber, and paint industries. Polymer Processes, Inc. has licensed Barden Corp. to produce ball bearing retainers from Nylasint powder. A continuous method of producing translucent Fiberglas building panels has been patented by Filon Plastics Corp. Linear electron accelerators are being used to irradiate polyethylene nuclear reactor cores by Applied Radiation Corp. An international department has been formed by the J. M. Huber Co., to handle foreign marketing of carbon blacks, clays, pigments, and inks. The Nalge Co., Inc. has been appointed distributor of its line of flexible vinyl tubing by Vogt Mfg. Corp.

Company expansions were again plentiful. A multi-million dollar plant for the production of Saflex polyvinyl butyral has been opened in Trenton, N. J., by Monsanto Chemical Co. Two plants were consolidated into larger quarters by Tidland Machine Co., Camas, Wash. A multiple-story mixing facility has been opened by Narmco Resins & Coatings Co. A major chemicals plant near Winfield, W. Va., has been scheduled by Union Carbide Corp. Borden Chemical Co. is building an adhesives and coatings plant near Toronto, Ont., and Dow Chemical Co. is erecting an acrylonitrile facility at Freeport, Tex. Shell Chemical Co. is erecting production facilities for mono-, di-, and triallylamines at Martinez, Calif. A 25,000 square-foot plant is being built by Instron Engineering Corp., in Canton, Mass. New equipment has been added at Archer-Daniels-Midland Co.'s resin plant in Pensacola, Fla. Hull-Standard opens a new manufacturing plant soon, near Hatboro, Pa. Molded Fiberglass Co. has purchased a new building in Ashtabula, O. New facilities will enable Allied Chemical & Dye Corp.'s Barrett division to double its melamine output. Minneapolis-Honeywell Regulator Co. has opened a $1.5-million industrial valve production plant at Fort Washington, Pa. Stanford Research Institute, Menlo Park, Calif., has opened a new plastics laboratory.

New Materials to be noted (see pages 928-9): plasticizer intermediate; an all-PVC spray plastisol; black phenolic material; solid, phthalate plasticizer; liquid urethane casting resins · latex plasticizer; asbestos reinforcements; and a two-stage, filled phenolic.

New Equipment of interest (see pages 930-1): dielectric test bridge; horizontal laboratory mixer; high-vacuum ball valves; portable pipe-wall gage; threaded aluminum insert; and a concentric, rotary bore tool.

New Products worthy of mention (see pages 932-4): all-PVC lift check valves; nylon-reinforced glazing; interlocking styrene panels; colored nylon hardware; polyethylene meat bag; nylon hose couplings; and a high-density polyethylene nursing bottle.

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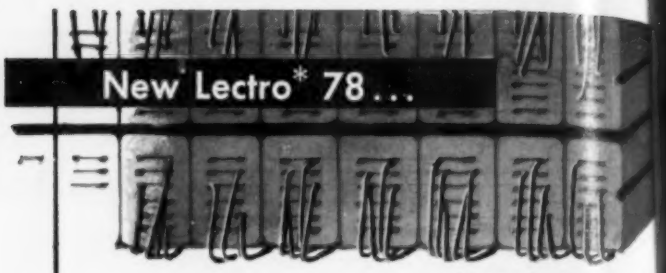
New Lectro* 78...



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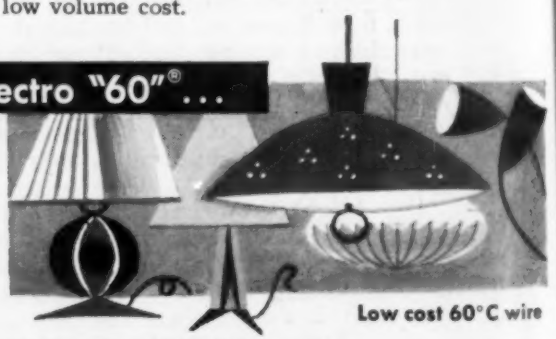
Lectro "60"®...



Low cost 60°C wire

"Dutch Boy" Stabilizer. For lowest volume cost

In 60°C wire, Lectro **60** lead stabilizer provides much the same benefits as Lectro **77** ... combined with rock bottom volume cost.

PLASTICS TECHNOLOGY

NOVEMBER, 1957

EDITORIAL: Don't stand still, keep growing!

There is much talk in the plastics industry, as well as in other lines of business, that 1957 is the prelude to a serious recession. Too many people say that business is bad and getting worse. But is it?

It is only natural for some businessmen to mistake an increase in competition for a decline. Actually, consumer purchases in 1957 are running 5-7% ahead of the previous year. If you did not get your share of this increase or if your firm's sales decreased, the odds are that you were bested by your competition, and were not the victim of a general decline in business. The cure for this type of "bad business" lies in continued technological improvements and better selling.

A good name for the period we are in now is "hard-times prosperity." Our economic machinery is breaking records in production, sales, and income, but business continues to moan and wail and half-suspect that hard times are coming. As "Sales Management" magazine asks, "How mixed up can a nation get?"

•

The technically quiescent compression molding field is a case in point in the plastics industry. Compression molding was the first processing method for plastic products, and there still is too much belief that optimum development of thermosetting materials, equipment, and processing techniques has already taken place. In other words, compression molding is as perfect as it can be, and we have no further place to go in the future.

Does anyone seriously believe this; compression molding has reached a state of perfection? After having the entire plastics field to itself, the compression molding field was stunned by competition from the newly-emerged injection molding and the thermoplastics. The compression molding field emerged from the combat licking its wounds, and still is sitting in defeat awaiting the end.

Plastics technologists know that there is no one perfect plastic material and molding method that is ideal for all product applications. Each material and method supplements the others, and each plastics application has its own standards of satisfaction or failure.

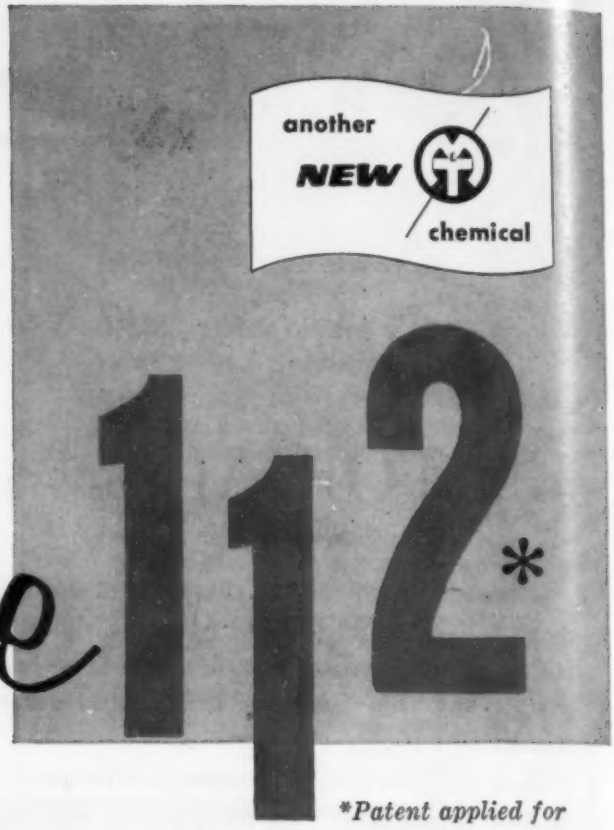
•

Industries, as well as companies, cannot hold still and live. If growth and improvement is not being striven for, the result is a decline that may or may not be perceptible at the outset. Stillness, after all, is an aspect of death; improvement and change is a sign of growth.

We firmly believe this philosophy to be equally applicable to our magazine. While PLASTICS TECHNOLOGY has achieved noteworthy results in its short span of existence, we consider it far from perfect. Our expressed editorial philosophy is a framework for future changes and improvements in the magazine. Based on suggestions and opinions from our readers, we are looking forward to many innovations and changes in 1958, our fourth year of growth.

Arthur M. Merrill

Editor



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**Patent applied for*

. . . an entirely new concept in barium-cadmium stabilization

. . . complete freedom from fatty acids and octoates

Thermolite 112 is used in:

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. . . plastisols and organosols.

CLEAR VINYLS —to approach optical clarity with outstanding light stability —superior heat stability gives excellent initial color and holds color during processing—offers freedom from "plate out".

PIGMENTED VINYLS—initial color maintained with no color drift during processing.

Metal & Thermit now brings you an entirely new type of stabilizer for polyvinyl chloride film, sheeting, extrusions, and dispersions. Thermolite 112, the first barium-cadmium stabilizer completely free from fatty acids and octoates, offers heat and light stability, clarity, and heat sealing and printability characteristics heretofore unapproached by a barium-cadmium system. Hose manufacturers will be especially pleased at the increased water resistance and lower hazing with Thermolite 112.

For all applications, the unique chemical structure and physical properties of this new stabilizer provide unlimited opportunity for lowering costs and improving quality. "Plate out" on calender rolls is reduced to a minimum. Substantial savings result from the powerful action of Thermolite 112 permitting the use of very small quantities of stabilizer for many formulations. In some cases, Thermolite 166, our zinc stabilizer, can be substituted for part of the barium-cadmium, thus further reducing costs. Both of these new Thermolite stabilizers are liquid and can be added directly to the plasticizer, thereby eliminating costly grinding or pre-blending.

Literature providing details about Thermolite 112 and Thermolite 166 is available upon request.

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PLASTICS TECHNOLOGY

Causes and Control of Calender Roll Plating of Vinyl Compounds

Results of an investigation of the plating effects of barium-cadmium stabilizers, chelating agents, pigments, resins, scrubbers, and stearic acid.

L. G. HOWARD,* *Development Engineer,*
and
R. C. HESS, *Group Leader,*
Calendered Film & Sheeting Products Development Group,
Bakelite Co., Bound Brook, N. J.

ONE of the most critical problems encountered in calendering film and sheeting is "roll plating," a severe coating deposited on the calender rolls under certain processing conditions. This coating not only creates an unsatisfactory sheet surface, but also interferes with the sheet transfer from roll to roll, thus slowing the rate of production.

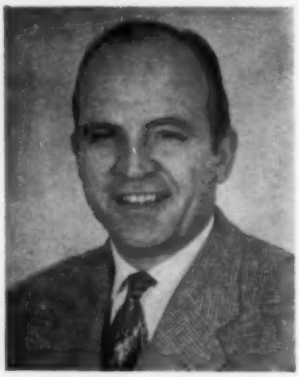
After considerable observation and effort directed at finding a solution to this problem, the Bakelite laboratories recently devised a means of determining whether a vinyl resin compound will plate in production. Test results showed that such formulation variables as chelating agents, pigments, resins, scrubbers, and stearic acid all cause or influence plating to some degree. In most instances, however, the plating was found to be directly proportional to the barium-cadmium stabilizer concentration. With the aid of these findings, the firm has been able to develop barium-cadmium stabilized film and sheeting compounds that cause little or no plating.

Test Method

Early attempts to measure roll plating by means of a modified two-roll mill test were inadequate. Wide plating differences could be detected, but small differences, which are important in commercial calendering, could not be detected readily. Later, observations in processing roll-plating compounds revealed that the majority of plating occurred on the calender rolls. As a result, a combination mill and calender test was developed.

This test is performed as follows: (1) Fluxing a small batch containing a selected pigment on a two-roll mill, and calendering it into sheeting 0.010-inch thick; (2) Following this stock with a white "cleaner" batch which picks up the pigment deposited along with the plating component; and (3) Measuring the reflectance of a 0.040-inch molded specimen of the "cleaner"

*Now technical representative, Calendered Film & Sheeting Products Div., Bakelite Co., Cincinnati, O.



Lafayette G. Howard was born in Gasconade, Mo., in 1917. He attended the University of Missouri, receiving a B. S. in Chemical Engineering in 1940. He served as a Public Health Engineer and Assistant Supervisor of Shipbuilding before entering the United States Navy in 1943. From that time until 1946, he served as Engineering Officer on Destroyers. He joined Bakelite Co. as a Development Engineer and, in 1956, was named Technical Representative, Sheeting Division. Mr. Howard is an active member of SPE, and makes his home in Cincinnati, O. He is married and has two children.

Raymond C. Hess was born in Jonestown, Pa., in 1919. He received a B. S. in Chemistry from Lebanon Valley College in 1941, and in 1943 was awarded a M. S. in Organic Chemistry by Lehigh University. He joined Bakelite Co. following graduation, and served as a development chemist until 1944. From 1944-1946, he served in the U. S. Navy. He rejoined Bakelite on discharge from the service, working on color pigmentation of vinyls and polyethylene. In 1953, he was named Group Leader in charge of Floor Coverings Development, and in 1956, became Group Leader in charge of Calendered Non-Rigid Film and Sheeting Products Development. Mr. & Mrs. Hess and their two children reside in Westfield, N. J.

batch and noting the differences in reflectances, at wave-lengths of 700 and 500 millimicrons, that indicate the degree of plating.

The equipment required for the test is a small scale replica of plant milling and calendering equipment. The apparatus consists of an 8 by 16-inch two-roll mill (rolls to be of equal speed, 30:30 revolutions per minute and 62.8 feet per minute); a four-roll inverted L-type calender; a pryometer (0-250° C.); a micrometer caliper (0-1 inch) graduated in units of 0.0001-inch; a mill knife; leather gloves; and a precision timer or stop watch. The process should be performed by experienced operators.

Test formulations of an orange-pigmented test batch and white cleaner, prepared in accordance with normal laboratory weigh-up and blending procedures, were as follows:

	Orange Base	White Cleaner
Bakelite vinyl Resin VYNW	63.50%	64.10%
"FLEXOL" Plasticizer DOP	29.23	31.00
Epoxidized soybean oil	2.00	—
Antimony Oxide	1.00	—
"Tribase" **	—	2.00
"Silene" EF #	—	2.00
Anatase titanium dioxide	—	0.60
"Deenax" ##	0.10	—
Stearic Acid	—	0.30
Color pigment (Molybdate Chrome Orange in DOP)	2.67	—
Stabilizer (Barium-Cadmium plus Chelating Agent)	1.50	—
	100.00%	100.00%

The test is conducted in the following manner. The mill roll surface temperatures are adjusted to 170° C., and calender roll temperatures are adjusted, as follows:

Offset roll — 155° C.
Top roll — 160° C.
Middle roll — 165° C.
Bottom roll — 170° C.

The four-pound test preblend is poured into the bite of the mill rolls (set for approximately 0.085-inch sheet), fluxed, and given five end passes. The material is allowed to band around the mill rolls, and the excess preblend on top of the mill guides and frame is brushed away. The batch is removed in the form of one pig and fed into the calender whose guides are adjusted to make a 10-inch wide sheet, using the center portion of the rolls. The calender clearance is set to produce a 0.010-inch sheeting at 35 feet per minute; then the entire batch is processed.

The next step is to flux 600 grams of the white cleaner on the mill, using clean paper in the mill pan and a pair of clean leather gloves. During fluxing, the unfluxed preblend is added by collecting it by hand from the paper in the mill pan. The paper is not to be shaken over the mill. If any of the pigmented test batch is noted in the cleaner during fluxing, the mill should be stopped and the pigment removed. The cleaner should be allowed to band around the mill for one minute to remove all plating. When running a series of tests, separate gloves and paper for the test and cleaner batches must be used. With the calender guides placed at the edges of the rolls, the white cleaner is fed into the calender, where it is allowed to band around the rolls in normal fashion for a period of one minute. If plating is extremely heavy, an extra one-half minute is allowed before passing the cleaner through the calender.

** A hydrous tribasic lead sulphate supplied by National Lead Co.
# A hydrous calcium silicate supplied by Columbia-Southern Chemical Corp.
##A dibutyl p-cresol supplied by Enjay Co., Inc.

Table 1. Effect of Barium-Cadmium Stabilization on Plating.

Stabilization	Reflectance R_{700}	Reflectance R_{540}	Difference	Remarks
1.0% Barium-cadmium laurate, 0.5% Chelator A	90.5	52.5	38.0	Heavy plating
0.75% Barium-cadmium laurate, 0.5% Chelator A	93.5	62.0	31.0	Moderate plating
0.50% Barium-cadmium laurate, 0.5% Chelator A	93.0	75.0	18.0	Non-plating
1.0% Barium-cadmium oleate, 0.5% Chelator B	93.0	78.5	14.5	"
1.5% Barium-cadmium oleate, 0.5% Chelator B	91.5	77.0	14.5	"
2.0% Barium-cadmium oleate, 0.5% Chelator B	91.5	75.0	16.5	"
1.3% Barium-cadmium complex, 0.1% stearic acid	93.5	78.0	15.5	"
1.3% Barium-cadmium complex, 0.3% stearic acid	92.5	83.5	9.0	"
2.0% Barium-cadmium complex, 0.1% stearic acid	92.5	61.0	31.0	Heavy plating
2.0% Barium-cadmium complex, 0.3% stearic acid	91.5	63.5	28.0	Moderate plating

Table 2. Effect of Barium-Cadmium Ratio on Plating.

Ba/Cd Ratio	Reflectance R_{700}-R_{540}	Remarks
60/40	25	Slight plating
55/45	19	Non-plating
50/50	17.5	"
45/55	16.5	"
40/60	16.0	"

For a test sample, a 0.040-inch molded specimen is prepared from the 0.010-inch white cleaner sheeting, making sure that the sample is representative of the colors. In other words, if color streaks appear, sufficient samples should be cut to superimpose the plies at right angles. One 2¼ by 2¼-inch specimen is cut from the 0.040-inch molded piece and submitted for total reflectance measurements over a white background.

The amount of plating is calculated by recording the reflectance at wavelengths of 700 and 540 millimicrons. The latter is subtracted from the former, and the difference value is a measure of plating which is interpreted as follows:

0-20	Non-plating
20-25	Slight plating
25-30	Moderate plating
Over 30	Heavy plating

In most cases, a value under 20 has been sufficiently free of plating so as not to cause difficulty in production work, based on experience. While all compounds with stearic acid plate to a slight degree, the plating is of such a low magnitude that it generally does not affect processing of high-gloss sheeting. To be completely non-plating, a value of less than eight is required.

Resin Modifiers

During the production of barium-cadmium stabilized film, it was noted that temperature, thickness, and calendering speed were important variables that had effects on plating. With the solid barium-cadmium stabilizers, (some are liquids) it was observed that the higher the temperature, the more the plating. While all of the factors associated with plating are not understood clearly, it is reasoned that the compound is more fluid at elevated temperatures, and the plating components are diffused more readily throughout the material. The plating components, therefore, make contact with the calender rolls and form a heavy coating.

In general, more plating occurs with thinner films. This, again, is associated with higher temperatures and the fact that diffusion of the plating components is unchecked. Higher calendering speeds result in less plating. Often, plating will be observed during the start of a new run, but is reduced as the speed is increased.

In general, the more flexible a compound, the more severe the plating problem. The greater diffusion resistance of the stiffer compounds reduces the concentration of the plating components coming in contact with the calender rolls. Coupled with the fact that stiffer compounds tend to scrub or scour the rolls and prevent excessive build-up, this results in less plating. The effects of the barium-cadmium stabilizers, chelating agents, pigments, resins, scrubbers and stearic acid also were observed.

Barium-Cadmium Stabilizer

As previously mentioned, most of the plating that occurs has been attributed to the amount of barium-cadmium stabilizer contained in the compound. This is particularly true with the barium-cadmium laurates. Concentrations of 0.5%, while considered to be non-plating, are proportionally less stable. Based on actual production experience, reflectance measurements (R_{700}-R_{540}) of 0-20 are virtually non-plating. Table 1 indicates that the higher the concentration of stabilizer, the more severe the plating.

With a barium-cadmium oleate concentrations of 1.0, 1.5, and 2.0% were non-plating (corresponding reflectance differences were 14.5, 14.5, 16.5). Barium-cadmium complex 1.3% with 0.1 and 0.3% stearic acid was equally as good (corresponding reflectance differences were 15.5 and 9.0). A suspension of barium-cadmium laurate used at 1.3% concentration was non-plating (reflectance difference 11.5), while 2.0% was classed as heavy plating (reflectance difference 39.5).

In addition to the concentration of the stabilizer, the barium-to-cadmium ratio also affects plating. As shown in Table 2, the higher the barium content, the greater the plating. These plating results were obtained with 2.0% epoxidized soybean oil, 0.75% Chelator A, and 0.75% of the barium-cadmium stabilizer.

Table 3. Effect of Chelating Agents on Plating of Compounds with Barium-Cadmium Stabilization.

Ba-Cd Laurate Stabilizer Content	Chelating Agent	Reflectance R_{700}	Reflectance R_{540}	Reflectance Difference	Remarks
1.0%	0.5% Chelator A	90.5	52.5	38.0	Heavy plating
"	0.75% Chelator A	90.5	46.5	44.0	" "
"	1.0% Chelator A	89.5	48.0	41.5	" "
"	0.5% Chelator B	92.5	52.5	40.0	" "
"	0.75% Chelator B	90.5	55.0	35.5	" "
"	1.0% Chelator B	91.5	57.5	34.0	" "
0.5%	0.5% Chelator A	93.0	75.0	18.0	Non-plating
"	0.75% Chelator A	92.0	68.5	23.5	Slight plating
"	1.0% Chelator A	93.5	74.0	19.5	Non-plating
"	0.5% Chelator B	93.5	75.0	18.5	"
"	0.75% Chelator B	93.5	75.5	18.0	"
"	1.0% Chelator B	93.0	75.5	17.5	"

Table 4. Effect of Chelating Agent Content on Plating.
(Compounds contained 2.0% epoxidized soybean oil and 1.0% barium-cadmium laurate)

Tri-iso-octyl Phosphite Chelating Agent Content, %	Reflectance R_{700}-R_{540}	Remarks
0	39	Heavy plating
0.25	37	" "
0.50	34	" "
0.75	32	" "
1.00	30	Moderate plating
3.00	14	Non-plating

Table 5. Effect of Resin on Plating of Stabilized Compounds.

Bakelite Resin	Stabilization	Reflectance R_{700}	Reflectance R_{540}	Reflectance Difference	Remarks
VYNW	1.0% Barium-cadmium laurate, 0.5% Chelator A	90.5	52.5	38.0	Heavy plating
QYSQ	1.0% Barium-cadmium laurate, 0.5% Chelator A	93.0	43.5	49.5	" "
VYNW	1.0% Barium-cadmium oleate, 0.5% Chelator B	93.0	78.5	14.5	Non-Plating
QYSQ	1.0% Barium-cadmium oleate, 0.5% Chelator B	92.5	79.5	13.0	" "

Table 6. Effect of Scrubbers on Plating of Stabilized Compounds.

Scrubber	Stabilization	Reflectance R_{700}	Reflectance R_{540}	Reflectance Difference	Remarks
Silene EF, 1.0%	1.0% Barium-cadmium laurate, 0.5% Chelator A	91.5	64.0	27.5	Moderate plating
Silene EF, 2.0%	1.0% Barium-cadmium laurate, 0.5% Chelator A	91.5	71.0	20.5	Slight plating
Silene EF, 3.0%	1.0% Barium-cadmium laurate, 0.5% Chelator A	91.5	78.5	13.0	Non-plating
Hi-Sil 110, 1.0%	1.0% Barium-cadmium laurate, 0.5% Chelator A	93.0	67.5	25.5	Moderate plating
Hi-Sil 110, 2.0%	1.0% Barium-cadmium laurate, 0.5% Chelator A	92.0	82.0	10.0	Non-plating
Hi-Sil 110, 3.0%	1.0% Barium-cadmium laurate, 0.5% Chelator A	91.5	83.0	8.5	Non-plating

Table 7. Effect of Stearic Acid on Plating of Stabilized Compounds.

Non-resin content, %:					
Epoxidized soybean oil	2.0	2.0	2.0	2.0	2.0
Barium-cadmium laurate	1.0	1.0	1.0	..	..
Barium-cadmium complex	..	..	..	1.3	1.3
Chelator B	0.75	0.75	0.75	..	..
Stearic acid	..	0.10	0.30	0.1	0.3
Reflectance difference, %	35.5	28.0	21.0	15.0	9.0

Chelating Agents

Chelating agents normally are a type of organic phosphite that does not function as a stabilizer itself, but must be used always in combination with metallic stabilizers. In combination with barium-cadmium stablizers, they (1) improve heat stability and clarity; (2) reduce dehydrochlorination; and (3) in general, act like antioxidants. The two chelating agents tested, tri-iso-octyl phosphite and 60% triphenyl phosphite in plasticizer, essentially are in the same class with regard to plating and stability, although the former offers better color (see Table 3).

Chelating agents, when used in concentrations consistent with production practices (0.5-1.0%), have no significant effect on plating. However, abnormally high concentrations reduce plating significantly, as shown in Table 4. With 2.0% epoxidized soybean oil and 1.0% barium-cadmium laurate, the plating results shown in Table 4 were obtained. It can be seen that concentrates above 1.0% are necessary to achieve non-plating.

Effect of Pigments

In the production of calendered opaque sheeting compounds, some color pigments were found to have a pronounced plating effect. It was observed that lead chromate and phthalocyanine pigments were partially soluble in the plating components, and became a part of the build-up on the calender rolls. Infra-red analysis of this plating revealed that practically all of it was the barium-cadmium laurate, with a small amount of pigment. Similar plating existed, no doubt, with other pigments. However, the presence of the above-mentioned pigments highlighted the condition and accelerated it to the extent that in but 3-5 minutes of calendering time, the bottom roll of the calender was covered completely. Such coating necessitated the use of a cleaner batch.

Since normal cleaner batches readily removed all of the plating from the calender rolls, it was felt that the incorporation of a small amount of a "scrubber" (various forms of silica) would effectively remove the plating as it was being deposited. It was learned, experimentally, that 3.0% of "Silene" EF prevented plating with all colors. "Silene" EF was used, therefore, in compounds with colors known to plate. This was recognized as a stop-gap measure, and efforts were directed toward the development of a plating test correlatable with production experience to assist in the formulation of non-plating barium-cadmium stabilizer systems without the use of a scrubber.

Effect of Resins

The choice of resins had little or no effect on plating. The comparisons shown in Table 5 illustrate this point. The minor differences indicated here in degree of plating from resin to resin are not considered significant.

Effect of Scrubbers

The term "scrubber" is used loosely in connection with vinyl formulations. However, for the purpose of this article, it will be confined to various forms of silica that are employed in standard cleaner batches. Materials such as "Silene" EF and "Hi-Sil" 110*, when incorporated as 1.0-3.0% of the formulation, prevent plating build-up because of their scouring or scrubbing action. This non-plating property is the only advantage to the use of scrubbers, but there are several disadvantages.

The scrubber is an additional ingredient to the formulation which requires grinding to break down any agglomerates; hence, it increases the cost of the compound. Materials of this type can be, and generally are, contaminated, and the contamination shows up as black specks in the finished article. In high-gloss products, scrubbers can cause a background surface effect that is rough and pebbly. In addition, they degrade the brilliance of various colors and require new color matches. A particularly objectionable point for the inflatables trade is that the scrubbers whiten if the sheet is extended. Scrubbers also reduce the clarity of the compound. It is apparent, therefore, that they should be used only as a stop-gap measure with their concentration kept at a minimum.

On the basis of the above and earlier work, and the urgency of solving the plating problem, the possibility of using "Silene" EF was investigated. It had been used previously in production work and, at the time, also was being used as a scrubber by suppliers of the barium-cadmium stabilizers. These suppliers employed it in a cleaner batch for two-roll mill plating tests. The effect of scrubbers is shown in Table 6.

Effect of Stearic Acid

Known to improve both initial and holding color, stearic acid also reduces plating of the barium-cadmium stabilizer systems. However, the role of stearic acid is unknown. In other formulations, it seems to form a thin protective film on the calender rolls which prevents sticking under normal operating conditions. This also could be the case with the barium-cadmium stabilizer. On the other hand, the stearic acid could surround the plating particle, and, in a sense, prevent it from making contact with the metal rolls.

A number of theories have been advanced regarding the activity of the stearic acid on plating, but none have been accepted completely. Of greater importance at this time are the facts that stearic acid reduced plating, and that optimum concentrations have been established. The effect of stearic acid on plating is indicated in Table 7.

Conclusions

Based on test results obtained from compounds of various barium-cadmium stabilizers using 2.0% epoxidized soybean oil as a part of the stabilizer-plasticizer system, the following conclusions emerged:

(1) Plating, in most cases, is directly proportional to the barium-cadmium concentration, and high concentrations result in increased plating.

(2) The barium-to-cadmium ratios, in most instances, have a direct bearing on roll plating. The higher the barium content, the greater the plating.

(Continued on page 911)

*A hydrated silica pigment supplied by Columbia-Southern Chemical Corp., Sub. of Pittsburgh Plate Glass Co.

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and
R. K. MULTER*, *Development Engineer*
Marbon Chemical Division
Borg-Warner Corp., Gary, Ind.

Cycolac in Rigid Thermoplastic Piping®

The strength properties, service conditions, installation, and handling of the material are discussed, together with its place in the over-all cost picture for piping.

PIPING based on rigid thermoplastic resins has many advantages, yet engineers and architects hesitate to specify these newer materials. In order to assure the use of rigid thermoplastic pipe wherever it is the most appropriate material, it will be necessary to better educate the consumer. In addition, the plastic material and pipe suppliers must provide the most reliable data on their materials, and amplify and interpret these data for those accustomed to working with metal.

To avoid misinterpretation, the field of rigid thermoplastic piping will be defined to consist of assembled systems of extruded pipe and injection molded fittings made of thermoplastics whose tensile modulus of elasticity is more than 100,000 psi. At present, this includes primarily three commercial materials: (1) the acrylonitrile-butadiene-styrene plastics (ABS), including both mechanical blends and Cycolac** polymer; (2) cellulose acetate butyrate (CAB), and (3) rigid polyvinyl chloride (PVC). Fittings also are being molded from modified styrene, but chiefly for use with polyethylene.

Flexible polyethylene is not included here because its properties and applications differ so greatly from those in this group. The new rigid polyethylenes have entered the field only lately, and information that is available currently on these materials indicates that they will fall somewhere between the flexible polyethylenes, and the true rigid thermoplastics, as defined in this article. Although ABS, CAB, and rigid PVC differ from each other in important details, they definitely can be grouped for comparison with the other piping materials.

Rigid thermoplastic piping costs in proper perspective from the viewpoint of piping engineers are shown in Figure 1. The Figure shows that rigid thermoplastic piping is more costly than plain or galvanized steel, but cheaper than most other piping systems. While it must have functional advantages to replace steel, it is an obvious prospect to current users of glass, stainless steel, brass, and other non-ferrous metals.

Plastics should be considered for all services that corrode steel. These usually are aqueous, and include lines for carrying acids and corrosive salt solutions; organics that contain wet corrosives such as crude oil; foodstuffs; fine chemicals that must not be contaminated by any metallic substances; and lines that are buried in corrosive soils. Rigid thermoplastic piping also may replace steel in non-corrosive service whenever its light weight and fast installation are exceptionally advantageous, as in cross-country pipelines, electrical conduit, city gas feeders, pneumatic conveyors, water wells, and lawn sprinkler systems. No doubt, other large markets will be added to these categories as users become more familiar with the rapid installation techniques possible with plastic pipe.

Strength Considerations

An engineer shopping for pipe has the problem of

Revised from a paper presented originally at the 13th annual National Technical Conference, Society of Plastics Engineers, Inc., St. Louis, Mo., Jan. 17, 1957.
*Now Vice President, Architectural Tiling Co., Keyport, N. J.
**Registered trademark of Borg-Warner Corp.

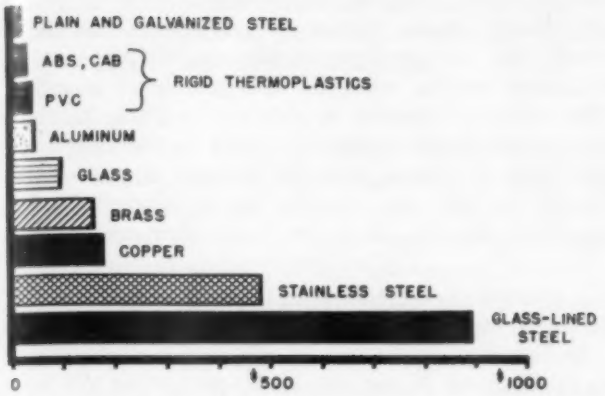


Fig. 1. Relative pipe costs per 100 feet (one-inch pipe, Schedule 40 or equivalent).

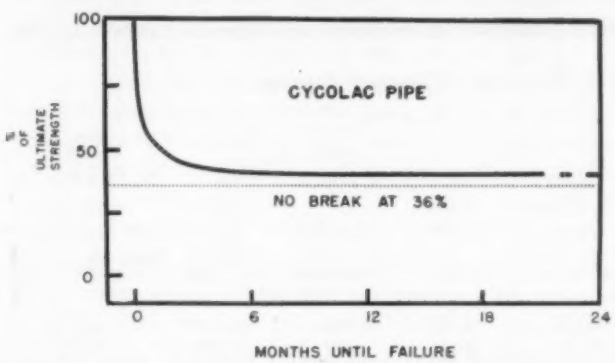


Fig. 2. Effect of load on time-to-failure of Cycolac pipe.

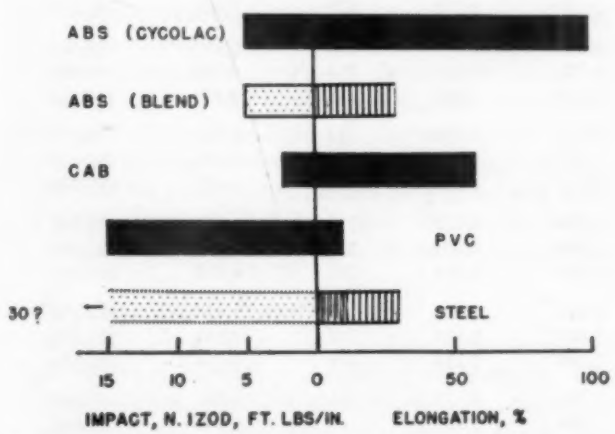


Fig. 3. Relative toughness and ductility of rigid thermoplastic piping materials at 70° F.

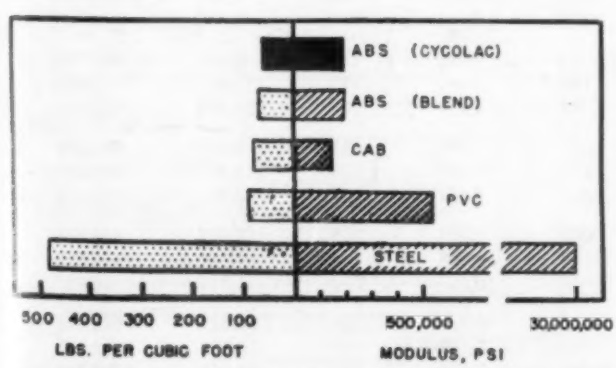


Fig. 4. Relative weight and stiffness of rigid thermoplastic piping materials.

conveying a particular fluid at a certain rate, temperature, and internal pressure through a known external environment in a line installed and maintained by mechanics. He aims for lowest total cost for the predicted life of the facility. The advantages he can expect to find in rigid thermoplastic piping are a combination of corrosion resistance, smooth interior, ease of installation, durability, and low cost offered by no other piping material.

Some of the available technical data are discussed in the following section on the basis of which rigid thermoplastic piping may be chosen properly.

Tensile Strength

The tensile strength reported for steel and other piping materials, including plastics, is measured by breaking test specimens within the short span of a few minutes. The burst strength of a pipe made from any material can be predicted with a simple equation known as the Barlow formula:

$$P = \frac{(2t)\,S}{D}$$

where P = Internal pressure, in psi., causing rupture; t = Wall thickness, in inches; D = Outside diameter, in inches; and S = Tensile strength of material, in psi.

This equation has been criticized on theoretical grounds, but it does give practical results within the limits of accuracy required by the design engineer. The formula is recommended by ASTM for use with steel piping. Naturally, the equation is valid only when the tensile strength and burst pressure are measured under identical conditions; temperature, chemical environment, specimen preparation, and time-to-failure all must be the same. This last restriction is very important, and must not be overlooked when making design calculations.

If a high load, near the ultimate strength, is applied to any material for a longer time than the conventional test requires, rupture will occur eventually. The lower the load, the longer the time; below a certain stress, failure will be postponed indefinitely. This "safe" or "effective tensile stress" is rarely published for the older structural materials because the working loads customarily are very much below the ultimate tensile strengths, even including arbitrary safety factors as high as five or six. It is plain that the difficulties in the past in designing plastics for tensile loadings have come from attempts to maintain static loads too close to the ultimate tensile strength of the material. High creep rates and related phenomena are natural consequences of working

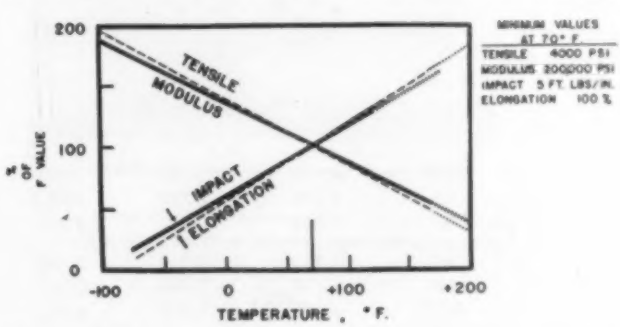


Fig. 5. Effect of temperature on the strength of Cycolac piping.

with any material at relatively high stress levels.

A typical load-time relationship is illustrated in Figure 2 which shows how time-to-failure of Cycolac, an ABS plastic, is lengthened as the stress is reduced. These data were obtained from tests at 70-95° F. on extruded Cycolac L pipe filled with a mixture of water and petroleum grease. The data agree with those obtained in creep tests of standard tensile specimens. No failure occurs at or below 36% of the short-time ultimate strength. It should be noted that this figure represents not the application of an arbitrary safety factor to the short-time tensile strength, but the measured, effective long-time tensile strength of Cycolac L.

All commercial materials vary somewhat from lot to lot. On the basis of many tests, it has been determined in laboratory work that the effective tensile strength of Cycolac L (and that is the long-term tensile strength) is a minimum of 1,400 psi. at 70° F. Once the effective tensile strength of any material has been found, the true strength of any size of pipe can be calculated readily, using the aforementioned equation. This work is simplified by referring to Table 1, which was prepared with dimensional data on the most common sizes of plastic pipe. To estimate burst strength, merely multiply the effective tensile strength by the multiplier factor, $\frac{2\ t}{D}$, in the Table. For convenience, the strength of Cycolac pipe has been calculated and the data included in Table 1.

In addition to the use of effective tensile strength in calculations, it also should be noted that the wall thickness of many piping systems is not necessarily determined by working pressures, but also by other considerations of fabrication methods, stiffness of the

Table 1. Strength and Dimensional Data for Cycolac Piping.

Nominal Pipe Size, In.	Schedule No.	D, Outside Diam., In.	t, Wall Thickness, In.	Inside Diam., In.	Cross-Sectional Area, Sq. Ft.	Factor $\frac{2t}{D}$	Pressure psi. $\frac{2tS}{D}$ Cycolac S = 1400	Plastic Volume Cu. Ft. 1000 Ft.	Cycolac Weight, Lbs. per 1000 Ft. (Sp. Gr. = 1.04)
1/4	SWP	....	....	....	....	....	...	....	.....
	40	0.540	0.088	0.364	0.125	0.326	456	0.868	56.330
	80	0.540	0.119	0.302	0.157	0.441	617	1.090	70.737
3/8	SWP	....	....	....	....	....	...	....	.....
	40	0.675	0.091	0.493	0.167	0.270	378	1.159	75.214
	80	0.675	0.126	0.423	0.217	0.373	522	1.506	97.733
1/2	SWP	0.600	0.050	0.500	0.086	0.167	234	0.597	38.743
	40	0.840	0.109	0.622	0.250	0.260	364	1.735	112.595
	80	0.840	0.147	0.546	0.320	0.350	490	2.221	144.134
3/4	SWP	0.855	0.053	0.749	0.134	0.124	174	0.931	60.418
	40	1.050	0.113	0.824	0.333	0.215	301	2.313	150.104
	80	1.050	0.154	0.742	0.433	0.293	410	3.006	197.077
1	SWP	1.140	0.070	1.000	0.235	0.123	172	1.631	105.845
	40	1.315	0.133	1.049	0.494	0.202	283	3.430	222.593
	80	1.315	0.179	0.957	0.639	0.272	381	4.435	287.814
1 1/4	SWP	1.420	0.085	1.250	0.356	0.120	168	2.471	160.358
	40	1.660	0.140	1.380	0.669	0.169	237	4.643	301.312
	80	1.660	0.191	1.278	0.881	0.230	322	6.114	396.774
1 1/2	SWP	1.730	0.115	1.500	0.583	0.133	186	4.046	262.569
	40	1.900	0.145	1.610	0.799	0.153	214	5.545	359.848
	80	1.900	0.200	1.500	1.068	0.211	295	7.412	481.009
2	SWP	2.250	0.125	2.000	0.833	0.111	155	5.781	375.164
	40	2.375	0.154	2.067	1.075	0.130	182	7.461	484.189
	80	2.375	0.218	1.939	1.477	0.184	258	10.250	665.184
2 1/2	SWP	2.570	0.125	2.320	0.961	0.097	136	6.669	432.791
	40	2.875	0.203	2.469	1.704	0.141	197	11.826	767.460
	80	2.875	0.276	2.323	2.254	0.192	269	15.642	1015.103
3	SWP	3.250	0.125	3.000	1.227	0.077	108	8.515	552.589
	40	3.500	0.216	3.068	2.228	0.123	172	15.462	1003.422
	80	3.500	0.300	2.900	3.016	0.171	239	20.931	1358.338
4	SWP	4.100	0.150	3.800	1.862	0.073	102	12.922	838.586
	40	4.500	0.237	4.026	3.173	0.105	147	22.021	1429.075
	80	4.500	0.337	3.826	4.407	0.150	210	30.585	1984.844
6	SWP	6.220	0.230	5.760	4.327	0.074	104	30.029	1948.762
	40	6.625	0.280	6.065	5.584	0.085	119	38.753	2514.915
	80	6.625	0.432	5.761	8.405	0.130	182	58.405	3790.238

material used, non-uniformity of the material, and possible maltreatment that the piping material may encounter before, during, or after installation.

Durability

Durability (or resistance to mechanical abuse) depends largely on toughness and ductility. Pipe and fittings are proof-tested readily for toughness or impact resistance by a dropping weight test, and for ductility by flattening in a vise. The first test indicates the magnitude of an accidental, hammer-like blow required to damage the piping beyond use, while the second test indicates the amount of deflection (crushing, twisting) that the piping walls can withstand without rupture under the irresistible forces of settling soils, shifting buildings, and other types of pressure or stress that an installed piping system might have to endure. ASTM standards on steel piping materials are practical guides to flattening and other useful proof tests on piping.

It was pointed out earlier that the rigid thermoplastics on the market vary between each other in physical properties. These differences, and their relative effect on toughness and ductility are shown in Figure 3.

Impact Strength

Laboratory tests have indicated that pipe and fittings made from resins whose notched Izod impact strength is more than two foot-pounds per inch at the temperature of use, probably cannot be broken during normal handling. Likewise, if made from resins whose tensile elongation is fairly high, they actually can be crushed flat without cracking. The significance of this latter test is not too well established, however, except perhaps for checking proper knitting of the material during the manufacturing of the pipe. The toughness comparison with steel, as shown in Figure 3, is somewhat qualitative, since the test methods differ slightly. It is evident, however, that the rigid thermoplastics vary greatly in toughness and ductility, and that these differences become even more pronounced with changes in temperature.

Other Mechanical Properties

Stiffness, weight, and interior roughness of the finished pipe also are important properties to consider. High stiffness means that fewer supports are needed for overhead piping; some flexibility, on the other hand, is a decided advantage for rigid thermoplastic piping over steel piping in underground work.

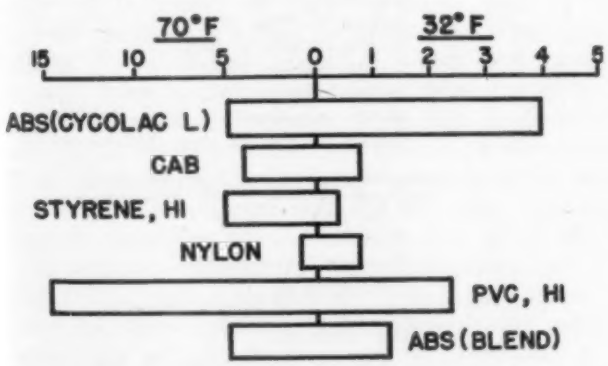


Fig. 6. Relative impact strengths (notched Izod) at 70 and 32° F. of various thermoplastic materials.

The light weight of rigid thermoplastic piping is one of its greatest advantages. It reduces transportation and installation costs, and makes possible a reduction in strength of supporting structures. Table I, giving commercial pipe dimensions, can be used to calculate the weight of any plastic required per foot by multiplying the volume figure by the density in pounds per cubic foot. The calculated weights of Cycolac pipe have been included. The specific gravities of rigid thermoplastics range from 1.02 for some pigmented Cycolac to about 1.4 for polyvinyl chloride. By comparison, the specific gravity of aluminum is 2.7 and that of steel is almost 8. Relative weights and stiffness of piping materials are shown in Figure 4.

The much smoother interior surface of rigid thermoplastic piping permits a higher flow than would be obtained with steel pipe. The pipes themselves do not scale, and wall deposits accumulate much more slowly, thereby maintaining good uniform flow for longer periods of time than would be possible with steel pipe.

Effect of Service Conditions

Having mentioned some of the more important

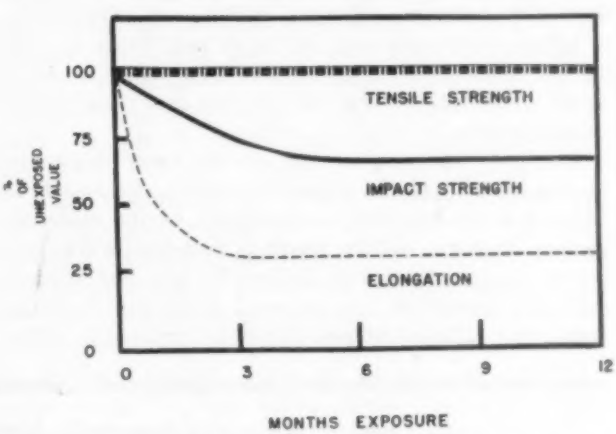


Fig. 7. Effect of Florida sunlight exposure on strength properties of unpigmented Cycolac.

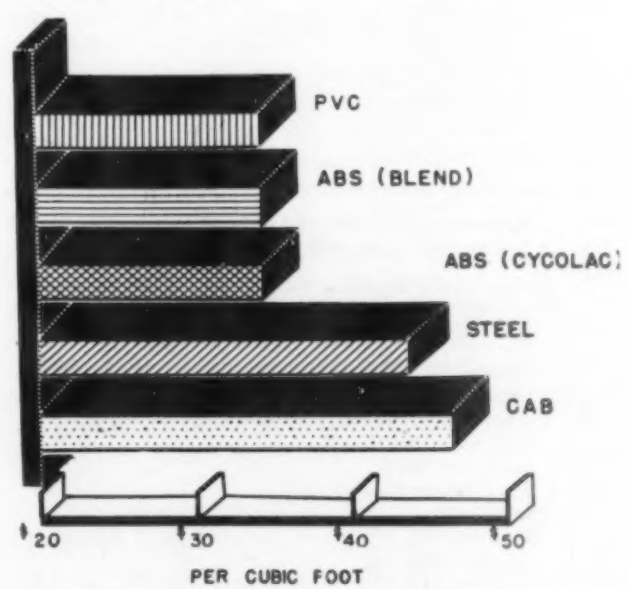


Fig. 8. Relative raw material costs of rigid thermoplastics used for piping.

mechanical properties of rigid thermoplastic piping systems, the way these properties are affected by various service conditions will be considered in the following section.

Effect of Temperature

The effects of temperature are readily measured and expressed quantitatively. The rigid thermoplastics, as do all materials, soften and weaken when heated, and lose toughness and ductility when cooled. The magnitude of these variations determines the useful temperature range of the material. Knowing what values of strength he requires, the piping engineer can determine by means of a graph like that of Figure 5, the burst strength at each temperature, and the useful temperature ranges for each material. Figure 6 shows how brittle some plastics become at slightly reduced temperatures.

Effect of Exposure

The effects of the other service conditions are more difficult to measure. Age alone does not harm the newer plastics, such as Cycolac, which contain no plasticizers or other possibly migrating ingredients. Moisture and humidity cause no changes in this and other water-repellent thermoplastics. Burial in soil shows Cycolac to be resistant to degradation. Shelf-aging in air at room temperature does not change any of Cycolac's characteristics.

Sunlight, however, is one of the most destructive agents known against organic materials. Its attack on Cycolac is evidenced by a reduction of the material's surface ductility, and the resulting non-ductile skin may crack to initiate brittle failures when the exposed surface is stretched. The apparent reduction in elongation and toughness of unpigmented Cyocolac is shown in Figure 7, which also illustrates that tensile strength is unaffected.

Cycolac is no worse in this respect, however, than the other rigid thermoplastics used in pipe. The seriousness of these shortcomings of rigid thermoplastics should not be minimized at the risk of alienating future consumers. However, this certainly does not mean that rigid thermoplastic piping cannot be used outdoors. Underground pipe, of course, is never exposed to sunlight for any length of time. Short or intermittent exposure, such as pipe, is often subjected to in storage yards, in partial shade, or in temperate climates, will not severely damage black pigmented Cycolac pipe. It should be stressed that the data shown in Figure 7 were obtained on unpigmented Cycolac.

Chemical Resistance

Chemical resistance certainly is the most elusive property to measure. With metals, a corrosion engineer often simply measures loss in weight of the material. However, in metals, plastics, and even glass, stress corrosion is prevalent. This is a phenomenon in which a fluid, which ordinarily does not harm a material, causes that material to fail in a brittle manner when a small tensile stress is applied. Too little is known at this time to predict theoretically when this may occur. The action appears to be attacked by the chemical at a sub-microscopic weak point where stresses will concentrate. Then, progressive growth of the crack causes rapid failure. This action is so severe when it occurs that it should not be attempted to list maximum safe tensile stresses for each chemical.

Since theory is inadequate, only stress-corrosion tests in the actual fluid of interest can guarantee that a plastic will withstand that fluid. These tests also will detect the more understandable type of failure in which

Table 2. Chemicals Apparently Resisted by Cycolac Under Stress at 70° F.

Acids in Water:

- Citric, 10%
- Hydrochloric, 30% (discolors)
- Lactic, 10%
- Nitric, 2%
- Oxalic, 10%
- Phosphoric, 50%
- Sulfuric, 50%

Alkalies in Water:

- Ammonium hydroxide, 15%
- Sodium hydroxide, 10%, 50%

Surface-Active Agents in Water:

- Armeen 18D, 1%
- Calgon, 1%
- Duponol C, 1%
- Emulfor EL-719, 1%
- Ethomeen C/20, 1%
- Santomerse No. 3, 1%
- Soap, bar, 10%
- Soap, Rubber Reserve, ½%
- Soilax, 1%
- Span 40, 1%
- Tergitol NPX, 1%
- Tween 40, 1%
- Vel, 1%

Inorganic Salts in Water:

- Calcium chloride, 10%
- Calcium hypochlorite, 10%
- Calcium sulfate, saturated
- Copper acetate, 10%
- Copper chloride, 10%
- Ferrous sulfate, saturated
- Potassium dichromate, saturated
- Sodium acetate, 10%
- Sodium bicarbonate, saturated
- Sodium bisulfate, 10%
- Sodium bisulfite, 10%
- Sodium carbonate, 10%
- Sodium cyanide, 10%
- Sodium chloride, 10%
- Sodium pyrophosphate, saturated
- Sodium tetraborate (borax), saturated

Organic Compounds & Miscellaneous

- Coca-Cola
- Glycerine
- Hydrogen peroxide, 30%
- Lubricating oil
- Mercaptans (C12 to C14)
- Sour crude oil

the plastic is softened or dissolved by the chemical. The important point to note is that the plastic must be stressed while immersed or the results may be incorrect. Withdrawal of the specimen from a stress-corroding fluid before loading permits the material to regain its strength. Therefore, any test data that are published on the chemical resistance of plastic materials should be taken with a grain of salt if the test itself was not performed while the plastic was under stress.

Extensive tests of this type on Cycolac have produced quite a lengthy list of recommended safe fluids (see Table 2). It will be noted that Cycolac is resistant to most aqueous systems, including acids and bases. Therefore, it can be used particularly in those systems where ordinary steel pipe fails very badly. The strong organic solvents which attack rigid thermoplastic piping are conveyed safely in plain steel, anyway, so this particular failing is not grievous. Any fluid not listed should be presumed corrosive, unless tests or manufacturer's assurances warrant otherwise. The traces of impurities usually present in commercial fluids sometimes may give anomalous results, unless the actual fluid is used in these tests.

Another characteristic to be guarded against with some fluids is the possibility of extraction of a harmful substance from the pipe. Examples would be the discoloration of fine chemicals by iron pipe, or the addition of distasteful plasticizers contained in some plastics when conveying food products through such pipes. Such phenomena have never been observed with Cycolac, which contains no plasticizer, despite extensive testing. The fact that water does not extract anything from Cycolac is shown, for instance, by the approval extended by the National Sanitation Foundation for the use of Cycolac pipe in potable water supply systems.

Importance of Processing Conditions

The properties summarized thus far are those of the materials when properly molded or extruded. Industry relies on the extruders and molders to form these rigid thermoplastics as recommended by their manufacturers, without overheating or otherwise degrading them. The suppliers of pipe and fittings would be wise to proof-test their finished products according to the principles of statistical quality control, as this is the only way to guarantee that the strengths inherent in the resins are being developed consistently in the formed pipe or fittings.

Cycolac products will have maximum strength if the resin temperature is kept below 500° F. in injection molding presses, and below 400° F. in extrusion. These are well above the minimum flow temperatures of the material in most machines, so degradation is avoided easily. Weak welds have been too common a source of failure with the rigid thermoplastics. Such welds are detected readily by a crush test, and an obvious rupture along the weld line indicates a weak point which may act in service to initiate joint leakage, accentuate stress corrosion, or cause a premature long-term burst failure. Many injection molded Cycolac fittings have been crushed flat without cracking, and the same can be done with properly extruded Cycolac pipe.

Failures in service can be caused by stress-raising any sharp internal corners designed into the fittings. Fitting designers would do well to copy the wide radii of cast metal fittings. A wide-radius notch, whether designed into the product or caused by an accident in manufacture or installation, scarcely affects strength. On the other hand, a very sharp scratch caused by a razor-like cutting edge can greatly reduce toughness and ductility of rigid plastic pipe.

Installation and Handling

Installation and handling should be much easier for rigid thermoplastic piping than for steel pipe. As with any new material, however, unfamiliarity has raised costs temporarily. Pipe-fitters must be trained properly in the use of plastic pipe. Threaded joints are never as strong as welded joints and are to be avoided, except when easy dismantling is important. Threading of Cycolac pipe is done easily with clean tools and standard threading techniques.

Solvent welding of the rigid thermoplastics is much easier than the welding of metals, and is one of the great advantages when using plastic pipe. Cycolac can be cemented quickly with a variety of solvents and adhesives, producing joints so strong that the pipe or fitting will fail before the bond does. Choice of cement depends on drying rate desired. This, in turn, is a function of the skill of the mechanic, the size of the fitting, the ambient temperature, the permissible time before the pipe is put into service, and other considerations.

A good technique for joining Cycolac pipe sections or fittings is to lightly wet the mating surfaces with solvent to soften them, followed by quickly pressing them together either with or without first again wetting the pipe surface. There should be a minimum of excess solvent used when the weld is made or setting time will be extended unduly. Most of the cements used currently have very little filling power. Pipe and fittings, therefore, must mate tightly before application of the cement or the joint will be weak. Good joints often are made with the outside pipe dimension actually a little larger than the inside dimension of the pipe fitting. The joint should not be disturbed, as for instance by dropping the pipe into a trench, until the cement has set properly. With some solvent systems, 10 minutes may be enough, but more time often is required.

Safety factors have not been discussed as yet, and the data given so far have been designed to predict the conditions of failure as precisely as possible. After estimating the strength of a piping system under the expected service conditions, the consumer's engineer should apply a safety factor derived from the degree of hazard involved, the likelihood of exceeding design conditions by water hammer, local overheating, etc., the chances of poor workmanship, the cost of repairs, and general economic factors. There are no rigid rules; the required safety factor should range anywhere from 1-10.

Over-All Costs

Let us examine the over-all cost picture with special emphasis on the near future. It was shown earlier in Figure 1 that rigid thermoplastic piping now costs

slightly more than plain steel, but less than other types of pipe. A rigid thermoplastic pipe fitting likewise costs a little more than twice that of the equivalent steel fitting. Because of unfamiliarity, contractors often bid higher or, at least, no lower on installation of rigid thermoplastic piping than on steel piping with which they are familiar.

As a result, the initial installed cost of a plastic piping system today usually costs more than that of steel. Plastics, then, will replace steel only where lower maintenance and replacement costs give an over-all economic advantage, or where chemical factors make steel completely unacceptable, as described earlier. Something, however, is wrong in this picture. Plastics have achieved much of their growth in other fields, and even their name itself, from the ease with which they are formed into complex shapes by various processes. Why shouldn't plastic piping, then, cost less than steel piping?

Figure 8 shows that of the rigid thermoplastics used for piping, one costs a little more than steel, on a volume basis, while the others cost less. This steel cost is derived from several sizes of low-carbon strip steel suitable for pipe manufacture, and cannot be used for precise comparisons with the thermoplastic molding pellets, but does give a general idea. The higher price of plastic piping does not result from material costs. Furthermore, steel prices have been rising steadily, whereas further reductions in plastics can be expected in the future.

Plastic pipe and fittings can be produced with a lower capital investment than that required for production of steel pipe. Labor requirements are relatively low. Plastics should be undeniably "easier" to form. It is only logical to expect that as the sales volume of plastic piping continues to grow and new advances in engineering and machinery are made, the price of rigid thermoplastic piping will become lower than that of steel. Faster production rates from equal capital investment should be the goal of plastic engineers, whether they mold or extrude plastics, design machinery, or manufacture the resins.

Resin suppliers can help by manufacturing materials designed for more rapid processing without sacrifice of other desirable characteristics. The melt-flow characteristics of Cycolac are conducive to high production rates in both extruders and injection presses, which certainly should be a step in the right direction.

Summary and Conclusions

To summarize, the four chief advantages of rigid thermoplastic piping are:

(1) Permanence, especially corrosion resistance when compared to steel, and toughness when compared to some other materials.

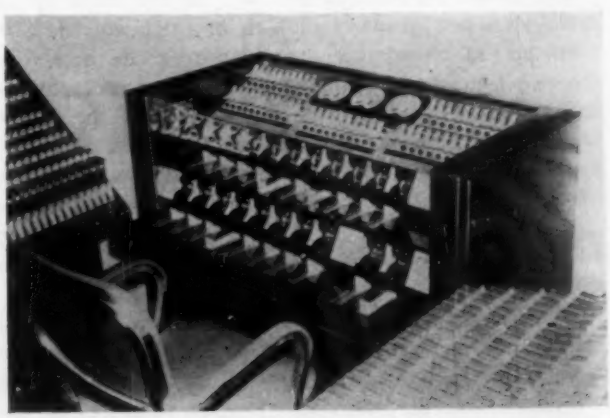
(2) Lower cost in comparison with all other pipe materials, except plain and galvanized steel, and a very favorable price future.

(3) Lower installation costs than for most other piping materials because of light weight, flexibility, good weldability, easy cutting, and toughness.

(4) Smoother interior than steel piping, thus minimizing resistance to fluid flow and the growth of wall deposits.

It is hoped that the techniques and data presented in this paper have helped to set rigid thermoplastics in proper perspective with the older materials, and that this information will encourage consumers to utilize rigid thermoplastics in piping wherever they are the most appropriate material. —THE END

Stage Lighting Control System



Console for the Lumitron Lighting Control System is compression molded of American Cyanamid's Beetle urea resin.

A new system of stage-lighting control, operable by one person, has been developed by the Lumitron division of Metropolitan Electric Mfg. Co., Long Island City, N. Y. Now in operation in many television studios, theatres, schools, and public auditoriums, the system and its console relieves the operator of having to control physically the intensity of a number of lights.

Lumitron uses maintenance-free magnetic amplifiers as the dimming device, American Cyanamid's Beetle urea plastic is used for the console pre-set units, handles, and slide bars. A dielectric, it requires no insulation, and the five colors of Beetle used in the slide bars aid in quick identification of circuits.

Lumitron systems are available in a wide range of circuit capacities, and are factory-wired and assembled. Beetle components are molded by Accurate Molding Corp., also of Long Island City. —THE END

The Compression Field

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Toledo, Ohio

AT one time, the compression field was the star in the plastic business. As with many companies, everything went well when competition was weak and business poured in by itself. As soon as competition (in this case, injection) appeared and business had to be sold, it developed a case of suspended animation. Business continually goes through these cycles: Most companies or industries tighten their belt—cut costs, improve products, develop new and better methods—beat the drums via promotion, advertising, publicity, etc.—and retain their position or go on to new levels. Actually, they gain stature for having weathered a severe storm.

Now this has to be done in the compression field. Injection gained momentum, moved rapidly, and stole the thunder while the compression field sat back and watched it rush by. Injection materials are good—they are steadily improving—methods are good, equipment is good, but more than anything else, *there is enthusiasm.*

Even with this huge surge, however, thermosetting materials haven't lost ground, they have stayed steady. Thermosets are as good as they ever were and other materials have not come up to their standards in many qualities. Now to progress, we need more improvements and then to beat the drums regarding those improvements—*and develop enthusiasm.*

Most major compression molders are using equipment methods and materials developed a decade ago. How can there be progress and expansion in the field? There have been the following, and other, major improvements in compression; however, few have taken advantage of the following:

(1) Faster cycling automatic presses have been developed.
(2) Heavier tonnage automatic presses have been developed.
(3) Preheaters have been developed for automatically feeding preheated powder.
(4) New automatic granulations of materials have been developed.

Obviously, if these cost saving procedures are not utilized, results will continue to be the same.

Witness a recent request by PLASTICS TECHNOLOGY for letters and information from people in the compression business for new information in this field—results were practically nil. Our progress is stymied by a basic problem—if our customers don't grow, we don't grow. If these customers won't grow, we must find customers that will grow.

Some companies, however, are doing something about this problem. As the custom molder continues to disregard possibilities of cost reduction, he is forcing more and more captive operations. This is coming about because companies are too hard hit by competition and cannot and will not pay exorbitant piece part prices. They study the merits of this new equipment and the new processes, realize its potential and above all—move.

When captives are established, they cost out parts that can be run automatically—redesign for automatics, eliminate inserts—investigate other parts that can be converted to thermosets, and expand. So there is progress in the field.

We must produce faster-curing materials, improved materials—color in cheaper materials and/or cheaper prices in colored materials—faster, better and larger presses, new procedures, and, in addition, *develop enthusiasm to produce a new look at thermosets and what can be done with them.*

There is an enormous field for both injection and compression. *Compression can be tremendously bigger than it presently is.* Loss of radio cabinets set the field back at one time and seemed to depress everyone associated with it. Other fields have had their setbacks, too, but, they recovered, got solidly behind their products, tightened up all the loose ends, developed enthusiasm, and went on to greater heights.

We, here at Bakers, have had our stumbling blocks engineering new equipment and then not being able to sell it to the people it was engineered for. We found a new market and definite progress is being made. By designing, offering and selling larger and faster traversing automatics, we have recently seen products converted from non-ferrous applications, stampings, and even cast iron to thermosetting materials. The whole industry can do the same. Compression isn't licked, it's only getting its second wind. If all involved tighten up, think ahead, move and *develop enthusiasm* —it can advance on to the next plateau. Now is the time to think and, above all, act!

—THE END

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High-Speed Tensile Tests of Thermoplastics

Exhaustive tests on polymethyl methacrylate and cellulose acetate-butyrate indicate that tensile properties are functions of time over wide ranges of test conditions.

THE dynamic mechanical behavior of plastics is of interest not only to the design engineer, but also to the solid-state physicist. For dynamic loads, engineers have had to design various plastic parts under material specifications derived mainly from relatively slow-rate mechanical testers. The Izod and Charpy impact machines have been used to supplement these slow testers. The results obtained with these machines have been extremely useful as a means of comparing relative shock resistances of materials. These results, however, did not yield suitable quantitative data. Today, the engineer required to design for dynamic loads with a minimum safety factor must know more about the viscoelastic properties of plastics.

Elaborate studies have been undertaken to correlate the mechanical behavior of polymeric materials with mechanical analogues or with molecular structure (1, 2)*. A number of theoretical approaches (3, 4, 5, 6) have been suggested for these correlations. Since experimental verification is lacking in many cases, many new techniques and instruments have been developed in attempts to solve various parts of the problem.

One of the major sources of experimental dynamic data is the non-destructive type of test. An example is the vibrating reed test (7, 8) in which a cantilever beam specimen is subjected to small strains varying sinusoidally with time. Similar tests use a rotating beam (9) or a torsional pendulum (10). The results of these procedures have led to studies from which theoretical or empirical equations have been derived. These equations often describe the dynamic response of the material quite well, but these studies are limited to small strains and cannot be used to predict fracture information.

Destructive-type testing of plastics, therefore, is receiving much attention. Since 1945, many tensile testing machines or devices have been developed for the purpose of fracturing polymeric specimens in periods measured in milliseconds. These machines have taken a variety of forms; a modified Izod tester (11), a flywheel type (12), a spring-actuated type (13), and pneumatically-operated types (14, 15). The machine described in this report is a pneumatically-operated unit.

Experimental data from these simple, high-speed tensile tests definitely are needed to complete the theo-

*Numbers in parentheses refer to bibliography at end of article.

retical study of viscoelastic materials. Such information also should be of immediate value to the design engineer. These test data, however, should be used with the utmost care. In addition to the complex time-dependent nature of the properties of plastics, such factors as temperature, water content, surface conditions, and age must be considered. Also, mechanical properties may vary because of difference in plasticizer content or the degree of polymerization of supposedly-identical batches of a given plastic.

Test Equipment and Procedure

Cellulose acetate butyrate and polymethyl methacrylate tensile specimens have been tested at crosshead velocities ranging from 0.02 to more than 5,000 inches per minute. The lower crosshead rate tests were conducted on an Instron tensile machine, while the higher rate tests were completed on a high-speed machine developed at this laboratory (16).

The general exterior appearance of the high-speed machine is similar to conventional slow-rate testers (see Figure 1). It is convenient to recognize that the machine consists of two principal parts; the loading system and the damping system, the latter being necessary to stop the crosshead after the test.

The major components of the loading system, recognizable in the general schematic view of the machine (see Figure 2), are the cylinder, the piston, the quick-opening mechanical valve, the blow-out disk, and the connecting rod to which the lower specimen grip is attached. For test preparation, both sides of the piston are subjected to a low, but equal, pressure of nitrogen gas. A net upward force exists as a result of unequal piston areas, and this force seats the piston and rod assembly positively against a mechanical stop. Next, the specimen is installed, instrumentation readied, and the final operating pressures adjusted on both sides of the piston.

Downward motion of the piston is obtained by rapidly discharging gas from the chamber below the piston by either of one of the two means: (1) opening the quick-acting mechanical valve, or (2) rupturing the blow-out disk by abruptly raising the gas pressure in the lower chamber only. By suitable selection of operating pressure and orifice size (the orifice is located downstream from the mechanical valve), specimen fracture times between 35 and several hundred milliseconds can be obtained. Fracture times between 1-10 milliseconds are obtained when the blow-out disk is used. The crosshead velocity of this machine, though not constant, approaches a uniform value for the latter 75-90% of the test, depending upon the test conditions employed.

After specimen fracture, the freely accelerating piston and rod assembly must be brought to a stop. This is accomplished by means of a dash plot arrangement referred to as the damping system. This system consists of two active compression springs, a rod stop, and the piston and cylinder assembly of the loading system. The stopping motion of the piston and rod assembly is a rapidly damped oscillation about a suitable equilibrium position.

Load-time data were obtained by use of strain gage-type load cells and their associated instrumentation. The output signal of these cells was amplified and fed into a pen recorder, a recording oscillograph, or a cathode-ray oscilloscope, depending upon the response required for the test conditions used. Elongation-time data were reduced from motion picture records. The gage markings used for these photography records were patterns scribed in wax deposited upon the surfaces of the specimens. For tests of three seconds or less duration (which included some Instron rates), an eight millimeter Fastax camera was used, while a 35 mm. Cameraflex camera was used for the longer tests. These film records were read by means of a microscope comparator equipped with a digital converter. Calibration tests indicated that a maximum error of ± 0.003 inch could

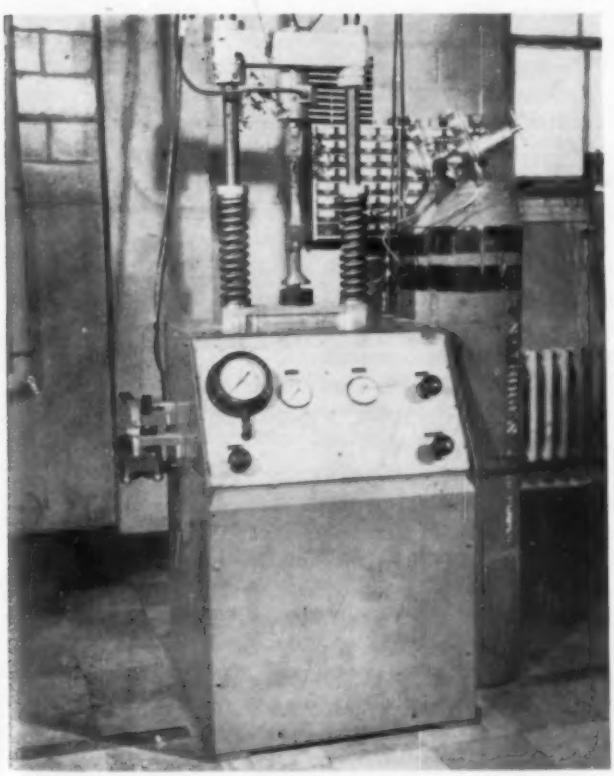

Fig. 1. Front view of high-speed tensile testing machine.

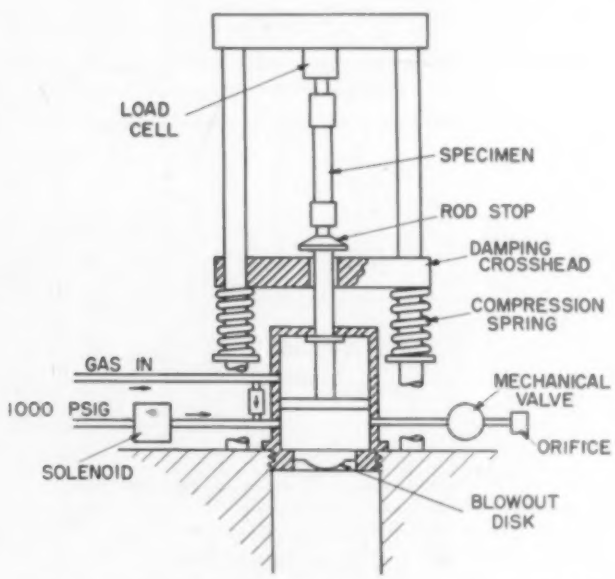

Fig. 2. Schematic view of high-speed tensile testing machine.

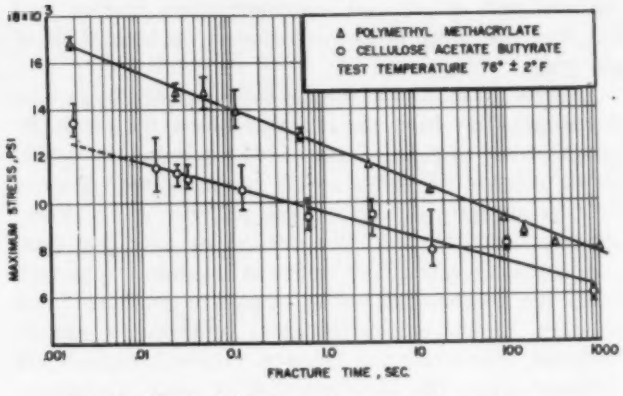

Fig. 3. Effect of fracture time on maximum stress.

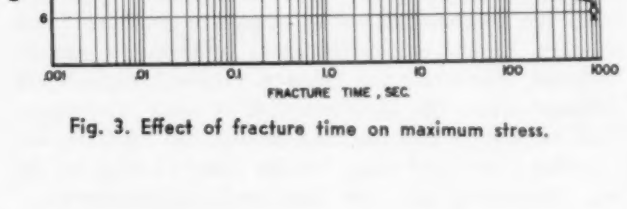

Fig. 4. Effect of strain rate on maximum stress.

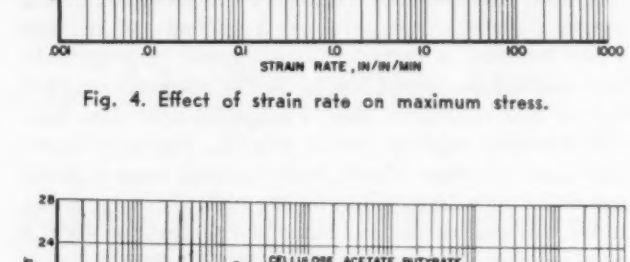

Fig. 5. Effect of strain rate on ultimate strain.

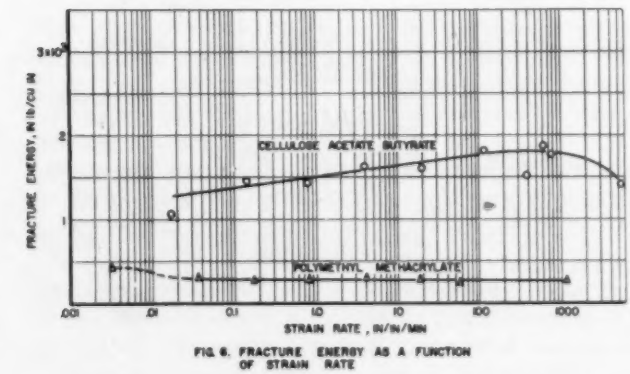
CELLULOSE ACETATE BUTYRATE
POLYMETHYL METHACRYLATE
FRACTURE ENERGY, IN LB/CU IN
STRAIN RATE, IN/IN/MIN
FIG. 6. FRACTURE ENERGY AS A FUNCTION OF STRAIN RATE

Fig. 6. Effect of strain rate on fracture energy.

be introduced by lens distortion, reading error, etc. This error was minimized, however, by reading each film frame of interest five times and using average values.

All tests were conducted at a room temperature maintained between 74-78° F. Before being tested, the specimens were dried for 48 hours at 122° F., then held at least five hours at room temperature in a desiccator. Five or more specimens were fractured at each test condition, and usually three motion picture records were made at each condition.

The cellulose acetate butyrate, 265A, and MH specimens were produced by injection molding. The uniform cross-sectional area or gage section of these specimens was nominally ⅛ by ¼ by ¾ inches. The polymethyl methacrylate, Plexiglas IA, and UVA specimens were machined from commercial sheet. The gage section of these specimens was considerably larger, ¼ by 0.40 by 3.75 inches.

Experimental Results

Approximately 75 tensile specimens each of cellulose acetate butyrate and polymethyl methacrylate were fractured in periods ranging from about 1½ milliseconds to 15 minutes. The tensile strengths or maximum stresses obtained for these fracture times increased approximately 100% at the shorter times for each material (see Figure 3). Average stress values and the scatter of these data are indicated; the data scatter for the injection-molded cellulose acetate butyrate specimens being the greater. All stress and strain values reported here were calculated from the original dimensions of the specimens' test sections; true stress value could not be calculated since Poisson's ratio is unknown for these materials.

When these maximum stress data were plotted against strain rate, fairly good semi-logarithmic relationships were obtained (see Figure 4). For the shorter gage length cellulose acetate butyrate specimens, the above fracture times corresponded to estimated strain rates from 0.02-5,000 inches per inch per minute. For the longer specimens, these times corresponded to estimated strain rates from 0.003 to about 1,100 in./in./min. The word "estimated" is used because nearly all strain-time curves obtained were non-linear, regardless of the machine being employed. It was necessary, therefore, to estimate the strain rate by using the slope of a straight line which intersected each individual strain-time plot at the 10% and ultimate strain values. This procedure usually gave a good approximation of the strain rate employed.

Maximum stress data obtained for polymethyl methacrylate at Massachusetts Institute of Technology (5) also are shown in Figure 4. These data were for strain rates of 0.001, 0.01, 0.1, and 1.0 inches per inch per minute. The tensile tests were conducted at 77° F. with polymethyl methacrylate containing various amounts of plasticizer. The MIT data presented for comparison had a plasticizer content of 5%, and data for other amounts of plasticizer definitely would not fit the stress rate curve shown. The tensile strength of the polymethyl methacrylate at 122° F. decreased about 35%. Preliminary data, not presented, gave a strength-strain rate

relation which also is semi-logarithmic, and this curve would be parallel to the 76° curve and about 3,600 psi. lower.

The ultimate strain and fracture energy of these materials are shown in Figures 5 and 6, respectively, as a function of strain rate. The softer or more ductile material, cellulose acetate butyrate, gave higher strain and fracture energy values. In both cases, the ultimate strain decreases with increasing rate. For the polymethyl methacrylate, an abrupt drop in ultimate strain was indicated near a strain rate of 0.01 in./in./min. This drop is due to the absence of large amounts of material flow above this rate, and other investigators (12) have encountered such a drop in this region.

Fracture energy values at 86° F. as a function of crosshead velocity have been reported for a rigid vinyl, ethyl cellulose, a phenolic, and methyl methacrylate (17). The cellulose acetate butyrate curve reported here is similar generally in appearance to the curve obtained for ethyl cellulose. Type I; the appearance of the two methacrylate curves are quite similar. No comparison of fracture energy values is presented since no data were found for which the volume of material could be determined.

Typical stress-strain curves for the cellulose acetate butyrate specimens at various strain rates indicate a substantial increase in the elastic modulus (see Figure 7). From a rate of 0.02-1.0 in./in./min., this modulus increased from about 200,000-260,000 psi. At higher rates, the modulus was difficult to evaluate accurately, but the data indicated that at the highest rate (5,000 in./in./min.), the value of the tangent modulus would be between 450,000 and 600,000 psi. Evaluation of the elastic modulus for the polymethyl methacrylate was more accurate because of the longer gage length employed. For the test conditions, this modulus increased from 330,000-650,000 psi. when the rate increased from 0.003-1,000 in./in./min., respectively.

The following empirical equation fit these data quite well:

$$E = 448{,}000\ R^{0.054}$$

where E=the elastic modulus in psi., and R-rate in in./in./min. This equation also fits reasonably well the modulus data reported by M.I.T. (5) for rates between 0.001-1.0 in./in./min., and for polymethyl methacrylate with 10% plasticizer content.

Summary and Conclusions

Much attention is being given to the investigation of the viscoelastic behavior of plastics. Instruments and testing machines have been and are being developed to test plastics under all types of conditions. This investigation describes a new machine and demonstrates the complex time-dependence nature of plastics.

A high-speed tensile machine and a standard Instron machine were used to fracture cellulose acetate butyrate and polymethyl methacrylate tensile specimens in periods ranging from 1½ milliseconds to 15 minutes. The operating principle of this pneumatically-operated, high-speed machine is described. The mechanical properties for polymethyl methacrylate are reported for strain from 0.003-1,100 inches per inch per minute, and for cellulose acetate butyrate for strain rates from 0.02 to over 5000 in./in./min. Load-time measurements were obtained by means of electronic equipment, while strain data were reduced from motion picture records.

Acknowledgments

Appreciation is expressed to the Samuel Feltman Ammunition Laboratories, Picatinny Arsenal, for supplying the injection molded tensile specimens. Appreciation also is expressed to Dr. L. V. Kline, of Purdue University, for his many suggestions, and to E. E. Johnson who conducted much of the experimental work.

Bibliography

(1) "Mechanical Behavior of High Polymers," T. Alfrey, Jr., Interscience Publishers, New York, N. Y. (1948).

(2) "Effect of Speed Test on Strength Properties of Plastics," A. G. H. Dietz, W. J. Gailus, and S. Yurenka, **Proceedings ASTM**, 48, 1160 (1948).

(3) "Vibrations of Elastic Systems Having Hereditary Characteristics," E. Volterra, **J. App. Mech.**, 17, 4, 383 (1950).

(4) "The Application of Nutting's Equation to the Viscoelastic Behavoir of Certain Polymeric Systems," R. Buchdahl and L. E. Nielsen, **Ibid.**, 22, 1344 (1951).

(5) "Viscoelasticity of Polymethyl Methacrylate—An Experimental and Analytical Study," J. K. Knowles and A. G. H. Dietz, **Trans. A.S.M.E.**, 177 (1955).

(6) Special Issue of Rheology, **J. Appl. Phys.**, 27, 7 (1956).

(7) "Vibrating Reed Test for Plastics," Stephen Strella, **ASTM Bull.**, 124, 47 (1956).

(8) "Forced Vibration of a Reed as a Method of Determining Visco-Elasticity," M. Horio and S. Onogi, **J. Appl. Phys.**, 22, 7, 977 (1951).

(9) "An Investigation of the Dynamic Mechanical Properties of Polymethyl Methacrylate," B. Maxwell. O.T.S. PB111642, U. S. Dept. of Commerce (1955).

(10) "A Recording Torsion Pendulum for the Measurement of the Dynamic Mechanical Properties of Plastics, and Rubbers," L. E. Nielsen, **Rev. Sci. Instr.**, 22, 9, 690 (1951).

(11) "Tensile-Impact: A Simple, Meaningful Impact Test," C. G. Bragaw, **Modern Plastics**, 23, 10, 101 (1956).

(12) "The Effect of Velocity on the Tensile Impact Properties of Methyl Methacrylate," B. Maxwell and J. P. Harrington. Tech. Rpt. No. 19A, Plastics Lab., Princeton Univ., Princeton, N. J. (1950).

(13) "A High Rate Testing Machine," C. M. Minke, A. R. Shoff, and H. A. Winnerling. Rpt. No. ABL/B-11, Hercules

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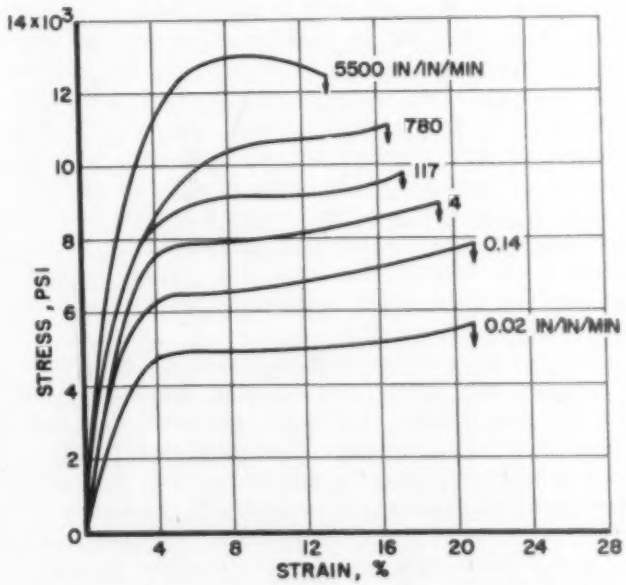

Fig. 7. Typical stress-strain curves for cellulose-acetate butyrate.

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Reinforced Plastics in Boat Hull Construction—Part I

The first of a two-part article in which glass-reinforced polyesters are shown to meet the design and strength requirements for successful boat construction.

THE recent fabulous growth of the pleasure boat market is due primarily to the increase in leisure time made available to millions of people by our rapidly expanding economy. The ownership of pleasure boats for relaxation has more than doubled in the last 10 years to the present annual rate of 500,000 boats (1)*. This demand for all types and sizes of boats is expected to continue upward with the growing economy. The only possible restraints are the lack of adequate facilities for mooring and servicing. In addition to this exceptionally large pleasure boat market, the need for military and commercial craft for various services is also expanding.

Accompanying this market expansion is the demand for bigger and faster boats in large quantities. This demand has created additional problems for boat designers and builders since mass production has been accomplished only recently, and by relatively few small boat builders. Further development and production of small boats will require experienced designers and builders to think in terms of large quantities to satisfy this growing demand.

Design Requirements

A successful boat design is directly dependent upon the ability of the boat to meet certain essential requirements; the degree of success being proportional to how well the design meets these requirements. In general, the essential requirements are safety, performance, appearance, suitability to mass production, and minimum maintenance.

Safety is considered the most essential requirement and, in addition to safety equipment such as life preservers, fire extinguishers and other Coast Guard or military requirements, is dependent on hull form and strength. In the development of the hull form, consideration must be given to providing the boat with adequate stability and sufficient freeboard to prevent swamping. With regard to hull strength, sufficient structural material must be provided to prevent failure due to impact in rough weather, when docking, and during normal handling in or out of the water.

Performance is the ability of the craft to provide

*Numbers in parentheses refer to bibliography at end of article.

serviceability in combination with operational economy. It is dependent on a number of factors; primarily intended service, and hull and propulsion characteristics. For good performance, the hull form must be designed for minimum drag, ease of handling, comfortable motion in a sea-way, and maximum dryness.

Appearance is one of the most important selling points of a boat. Many boats have been refused because of improper paint colors, lack of pleasing hull lines, unpleasant deck sheer or camber, and unattractive fittings. Great care must be given to these items in the development of a boat to be successful in the present competitive market.

Suitability to mass production is a necessity for any small boat design being developed today. No company can expect to retain its competitive position if it intends to build one of a kind or even several similar boats. High labor costs eventually will price it completely out of the market. Military requirements in times of emergencies also will depend on quantity production. All present-day boat thinking must be based on mass production for economy and market demand.

Minimum maintenance is essential for individual pleasure boat owners, as well as for military and commercial craft. Most pleasure boat owners are interested in fully utilizing their leisure time for enjoying their boats with their families and friends, and not for exhaustive maintenance. Military and commercial craft must be designed for minimum maintenance to reduce high operating and repair costs and valuable lay-up time.

Suitability for FRP

Of all the presently-available structural materials, fiber glass-reinforced polyester (FRP), probably is the most suitable material ever developed for boat construction. It far surpasses all other materials in being capable of providing the essential requirements for successful designs.

The advantages of FRP boat hulls are so exceptional and striking that their acceptance in the pleasure boat market, as well as the military and commercial market, is growing quite rapidly. This is obvious from the outstanding sales record of 5,000 boats in 1950 to an expected 40,000 this year.

Although adequately stated many times before, a brief summary of these advantages is presented to associate them with the essential requirements for a successful boat design. It is absolutely necessary to strongly emphasize that these advantages cannot be realized fully without adequate design and proper construction by experienced designers and fabricators. Also, since FRP is so new to the marine industry, the lack of sufficient service experience makes it difficult to determine whether any one hull will have all of these advantages.

For safety, FRP offers superior hull design in shape and structure with monocoque construction. FRP offers a one-piece hull, strong and light with high impact resistance. FRP hulls are homogeneous structures that will not leak when constructed without joints or fastenings.

For performance, FRP usually offers a lighter hull of any shape the designers require to obtain exceptional performance. FRP hulls are free from the tendency to soak up a substantial proportion of its own weight in water, as occurs in wood hulls.

For appearance, FRP offers hull forms and streamlining never before possible with such ease. FRP offers integrally molded colors that have some permanency, and hulls can be made to suit all consumer wants in appearance with much greater ease and lower costs.

As for suitability to mass production, FRP is the production man's long-sought material for true rapid-cycle, sub-component assembly and quantity control. Once adequately developed and with proper fabrication know-how, FRP hulls are suited best to quantity production at tremendous time and labor savings. Quantity production of FRP boat hulls has proven economical for both pleasure and military craft.

For minimum maintenance, FRP offers durability, freedom from leakage, freedom from accelerated weather and water exposure deterioration, freedom from seam caulking, freedom from seasonal painting, imperviousness to worms and dry rot, and reduction and ease of repairs.

Finally, FRP hulls have a strategic importance since the non-critical basic materials are available readily in this country without the need for importing in time of war when shipping space is at a premium.

Basic Materials

Since the development of the first thermosetting resin and fiber glass mat, tremendous strides have been made in these basic materials and the necessary forming processes to produce good, sound structural laminates. Continuous research and development by materials manufacturers, fabricators and military agencies has resulted in satisfactory resin formulations and fiber glass reinforcements, and the molding techniques to successfully mass-produce FRP boat hulls.

General purpose, rigid polyester laminating resin conforming to Military Specification MIL-R-7575A is used customarily for boat construction because of its relatively low cost and ease of fabrication. Rigid resin is resistant to marine weathering.

Flexible polyester resins have 40-50% tensile elongation, poor weather resistance, low moduli, and low strengths. However, they do have good impact resistance and considerable resilience. A relatively small amount (10%) of flexible resin added to a compatible rigid resin and molded as a reinforced laminate improves laminate impact strengths without significantly affecting other laminate properties (2). Pre-compounded, semi-rigid resins are available from various resin manufacturers.

At a slight additional cost, flame-resistant resin formulations are available that have approximately the same physical characteristics as general-purpose resins. Semi-rigid, flame-resistant formulations have the flexural strengths, moduli, and impact resistance of rigid polyesters modified with flexible resins. The inherent benefits of flame resistance during storage and added safety during service are the principal advantages achieved with this type of resin.

Commonly-used fillers consist mainly of calcium carbonate and aluminum silicate. The addition of fillers

has an effect on three laminate characteristics—surface finish, physical properties, and material cost. Inert fillers reduce shrinkage, so that crazing can be eliminated and a smooth, even surface obtained. Water absorption, moduli, and strengths can be reduced slightly by filler concentrations up to 40% by weight of the resin-filler mixture. (3). Larger percentages adversely affect strengths. Some FRP laminates for boat hulls contain a small percentage of these fillers. Additives such as antimony trioxide and chlorinated paraffin may be added to some resins as flame retardants. In this manner, polyester laminates can be made to be self-extinguishing.

Very often, fillers are considered undesirable in a molding because their pigmenting effect prevents full visual inspection of the laminate. The addition of fillers also can result in an unwanted increase of resin viscosity in molding processes or techniques that require low viscosity resins and, therefore, create considerable difficulties. Under certain conditions, fillers may slightly inhibit or accelerate the polymerization of the resin.

A major problem in the molding of FRP boat hulls by the contact process is the run-off of resin from vertical surfaces. One method of preventing resin run-off is to add small quantities of fine silica powder (about 2-5% of the resin weight). Filled resins of this type are thixotropic, and are available pre-compounded from various manufacturers.

Basic polyester resins generally are clear, but may be pigmented to any color from black to white. Preferably, they are colored with inorganic pigments or pigment flakes. Many organic dyestuffs change color during the polymerization of the resin as a direct result of the oxidizing action of the catalyst. The particular pigment chosen must fit the resin, since it may accelerate or retard resin cure.

Shrinkage of polyester resins during the polymerization process often results in crazing of resin-rich areas so that the fiber glass reinforcement texture becomes raised on the surface of the molding. For marine applications, it is preferable to have a surface that is smooth, moisture resistant, and impact resistant. By coating the mold with a thin, even layer of resin, suitably filled and pigmented, if desired, and allowing it to gel before proceeding with the structural laminate, a smooth, non-porous surface can be produced. Such a resin film or gel coat is used frequently to color a large molding or, by special compounding, to increase also the surface impact resistance. Semi-rigid polyester resins particularly resistant to impact are used in gel coats.

Fiber glass reinforcements most commonly used in FRP boat hulls have consisted, in general, of the following three types:

(A) Chopped strand mat conforming to military specifications MIL-M-15617-A. Usually, these are 1½ or two ounces per square foot in weight, and have a high solubility-type polyester binder. Heavier mats and especially-made preforms also are used in some hulls.

(B) Woven cloth Styles No. 1000-150 and 1044-150 conforming to military specifications MIL-P-1140-C. These are of plain weave construction with approximately equal strength in both directions, and weigh 9.66 and 19.2 ounces per square yard, respectively.

(C) Woven roving in Styles HG No. 56 or BS No. 6055, with approximately equal strength in both directions. These weigh approximately 25-27 ounces per square yard.

To insure good adhesion of the resin to the fiber glass reinforcement, a finish, usually, is applied to the glass fibers. For mats and woven roving, this usually is accomplished by sizing the fibers as they are formed with a resin-glass bonding agent. Generally, cloths are woven and cleaned before the finish is applied. For marine applications, a proper finish is of extreme importance in retaining the greatest percentage of laminate dry strength after extended periods of water immersion. During immersion, moisture tends to penetrate between the glass fibers and the resin, and the presence of the moisture tends to affect adversely the resin-glass bond. Slippage may occur, then, in the resin-glass bond when the laminate is stressed, reducing the laminate strength. Investigations indicate that silane finishes tend to reduce the loss of strength resulting from water immersion.

Laminates

Present FRP boat hulls usually are of 90% rigid and 10% flexible compatible polyester resin reinforced with one or a combination of two types of reinforcement having silane finishes. Selection of the type or types of reinforcement is dependent on economy, hull size, type of hull construction, service intended, molding method, and the fabricator's experience. Combinations of reinforcement types for hull skin laminates have been developed successfully and are being used presently in mass-produced boat hulls.

Practically all of the presently known molding methods are used for producing FRP hulls. The most commonly used method is contact, and is suitable for all types and combinations of reinforcements. This method probably is the most practical for larger hulls since a minimum strength mold or form is required without a large amount of additional molding equipment. The vacuum bag molding method is preferred by many fabricators, and is used primarily for mat reinforcement and, in some instances, for Style No. 1000-150 cloth reinforcement. This method tends to give higher laminate strength than the contact method. The production of FRP hulls by the pressure bag, autoclave, and matched metal die methods (4, 5, 6) is limited to relatively few fabricators since a high cost equipment investment is necessary, particularly for matched metal die molding.

The latter methods are usually limited to mat reinforcements, and can mass-produce higher strength mat-reinforced FRP hulls at a faster rate and minimum production costs. FRP boats fabricated by these methods have smooth surfaces both inside and outside of the hull skin, giving them greater sales appeal. In general, the present maximum hull size is approximately 16 feet for these methods, but some larger hulls have been produced by the pressure bag method.

For contact and vacuum bag molding, greater quality control as well as time and labor savings may be realized if a pre-determined shingling pattern is estab-

fished for placement of the reinforcement in the transverse or longitudinal direction. This method is clean and efficient, and does not require excessive gel time for a complete hull. It provides greater reinforcement overlapping; eliminates the difficulty of placing each complete layer individually; and prevents working back over the wet lay-up. This shingling pattern, if properly used, places the warp and fill of cloth and woven roving reinforcement in the transverse and longitudinal directions for maximum utilization of reinforcement and maximum hull strength.

Molding with higher pressure methods, generally restricted to chopped strand mat reinforcement, does not require as careful placing of the reinforcement since the pressure equally redistributes the glass fibers after the binder is dissolved.

Laminate Properties

In the production of FRP boat hulls, considerable variations in laminate thickness, specific gravity, and strength properties exist due to the different types of reinforcement and molding methods presently employed. Reinforcement and molding method are of primary importance to laminate properties, and variations due to resin formulations, humidity, etc., are considered secondary since their effect, while important, can be minimized by proper quality control. Good consistency of laminate properties is obtainable if proper care is observed throughout the molding operation, including basic materials handling and stowage.

For satisfactory and efficient design of larger FRP boat hulls, physical property data is essential, particularly laminate wet strengths. Table 1 presents design factors for laminate thickness, specific gravity, and percentages of reinforcement by weight for the most widely used types of reinforcement and molding methods in FRP boat hull production. Table 2 gives safe, ultimate wet-strength properties for the same laminates presented in Table 1. The data presented in Tables 1 and 2 are to be considered as tentative values based on a statistical analysis of available laminate test data from both governmental agencies and private sources. A considerable percentage of the test data used was primarily from large test panels prepared by various molders for boat hull application. These data are considered fairly representative of laminates obtainable in FRP boat hull manufacture.

All of the data are for laminates without inert fillers in the resin mix, and with premium silane finishes for the fiber glass reinforcement. Some of the laminates have silica powder added to the resin mix as a thixotropic agent. Most of the laminates contained 90% rigid resin and 10% flexible resin. The tests for tension, compression, flexure, and shear perpendicular to plies were conducted in accordance with Federal Specifications MIL-P-406b. The test method* for interlaminar shear consisted of bonding a steel plate to each face of the specimen and pulling the plates in opposite directions. All edges of the specimen were grooved slightly, leaving a one-inch square at the center of the specimen to resist the applied load in shear.

Table 3 presents impact resistance data for laminates in the wet condition. In these impact tests,** 18-inch square panels were supported without restraint on four edges, and a three-inch diameter hemispherical striker with variable controlled weights was dropped on the panels. This test was developed specifically for comparison of laminates for boat hull construction. Test results given in Table 3 clearly indicate the increase in laminate impact resistance with the addition of 10% flexible resin. It also is quite evident that woven roving laminates have the greatest resistance to impact loading.

Fatigue, creep and stress-rupture properties for FRP boat hull laminates are presently being investigated (7). Limited data (7, 8, 9) seem to indicate that loss in strength because of fatigue is appreciable and should be considered carefully for vibrating panels and frames; that creep of laminates at a normal temperature of 73° F., depending on direction of reinforcement, may or may not be negligible; and that stress-rupture occurs at reduced stresses with increased time.

FRP high-strength laminates reinforced with 181-136 cloth and subjected to flexural fatigue loading parallel to the warp in the standard condition will fail at approximately 40% of the ultimate static strength for 10-thousand cycles; 30% for 100-thousand cycles; 25% for one-million cycles; and 20% for 10-million cycles. For flexural fatigue loading at 45° to warp, the laminate will fail at a reduced percentage of static strength at the lower number of cycles, and will approach the percentage of strength parallel to the warp at 10-million cycles. Further reductions of these values are to be expected for laminates in the wet condition.# It will be interesting to see if the effect of fatigue on the strength of mat, heavy cloths, and woven roving laminates for boat hull construction will be of greater or lesser magnitudes due to their lower moduli.

Creep or deformation of FRP laminates under constant stress is dependent on time and temperature. For high-strength cloth laminates, creep parallel to the direction of the glass fibers is exceptionally small (7,8) at room temperature. Tests of FRP laminates reinforced with 181-136 cloth, tested at 73° F. in water, indicated that the deformation of rupture for tensile loads varies from 103.5-122.5% of the initial deformation as the stress intensity decreases from 80-40% of the static strength. For flexural loads, the deformation at rupture varies from 107.1-143.8% of the initial deformation as the stress intensity decreases from 80-40% of the static strength. Therefore, with initial deformation in the order of 0.760-1.451 percent for tension and 0.908-1.806% for flexure, creep parallel to the direction of the glass fibers in cloth laminates is so small as to be considered negligible. However, creep in other directions in FRP cloth laminates may not be negligible.

Tests of FRP mat laminates for boat hull construction, tested at 73° F. in water, indicate that at 70% of the flexural static strength, the increase in the 1.120% initial deformation after 1,000 hours is 71.4%. These laminates are continuing to endure this percentage of stress beyond 2,000 hours. With the stress increased to

*Test method and sample specified by Gibbs & Cox, Inc.; test apparatus designed and constructed by The Budd Co.
**Test panel and striker diameter specified by Gibbs & Cox, Inc.; test apparatus designed and constructed by The Budd Co.
#48 hours boil as per MIL-P-17549 (Ships)

Table 1. Design Factors for Fiber Glass-Reinforced Polyester Laminates*

Molding Method & Reinforcement	Thickness Per Ply, Inches	Specific Gravity	Nominal Weight Percent, Glass
Contact:			
1½-oz. mat	0.042	1.22	25
2-oz. mat	0.053	1.33	30
1000 cloth	0.016	1.65	48
1044 cloth	0.024	1.68	49
Woven roving (HG 56-1)	0.042	1.65	50
Vacuum Bag:			
1½-oz. mat	0.032	1.39	35
2-oz. mat	0.038	1.50	38
1000 cloth	0.015	1.67	50
Pressure Bag:			
1½-oz. mat	0.031	1.49	37
2-oz. mat	0.035	1.53	41
Autoclave:			
2-oz. mat**	0.028	1.61	48
Matched Metal Die:			
1½-oz. mat	0.025	1.60	47
2-oz. mat	0.027	1.63	50

*Tentative design factors based on limited test data.
**Specimen from full-scale boat test section.

Table 2. Safe Ultimate Wet Strength Properties of Fiber Glass-Reinforced Polyester Laminates*

Molding Method & Reinforcement	Nominal Glass Content, Percent	Tensile		Flexural		Compressive		Shear Strength	
		Strength, psi. x 10^3	Modulus, psi. x 10^6	Strength, psi. x 10^3	Modulus, psi. x 10^6	Strength, psi. x 10^3	Modulus, psi. x 10^6	Perpendicular psi. x 10^3	Interlaminar psi. x 10^3
Contact:									
1½-oz. mat	25	8.0	0.72	12.8	0.88	16.4	0.70	9.9	2.74
2-oz. mat	30	9.6	0.85	16.4	0.91	17.6	0.85	10.2	2.82
1000 cloth	48	24.8	1.91	34.9	1.96	21.3	1.71	11.5	2.57
1044 cloth	49	23.6	1.81	33.1	1.87	20.9	1.68	11.7	2.46
Woven roving	50	29.8	1.75	32.8	1.81	19.8	1.54	12.4	3.05
Vacuum Bag:									
1½-oz. mat	35	16.3	1.14	24.7	1.20	21.9	1.13	12.3	2.91
2-oz. mat	38	18.6	1.17	27.1	1.24	22.4	1.16	12.8	3.02
1000 cloth	50	24.2	1.94	35.3	1.97	21.7	1.55	12.1	2.65
Pressure Bag:									
1½-oz. mat	37	18.3	1.12	25.9	1.17	20.9	1.10	12.5	2.90
2-oz. mat	41	19.5	1.21	29.2	1.29	22.8	1.22	13.1	3.27
Autoclave:									
2-oz. mat	48	21.4	1.23	31.2	1.38	23.1	1.24	13.6	3.42

*Tentative values based on limited test data.

80% of the static strength, the time to failure is 0.65-hour, and the deformation at rupture is 119.5% of the 1.830% initial deformation. It appears that creep in FRP mat laminates at room temperature also is negligible. For FRP boat hulls operating in higher temperatures, creep may be of considerable importance.

Stress-rupture or load-carrying ability of FRP laminates, unlike creep, is definitely affected by the period under load. Test data (7,8) indicates a reduction in failing strength with increased period under load, even for short durations. FRP laminates in the wet condition have a strength level distinctly lower than that of laminates in the standard condition. A high-strength FRP laminate reinforced with 181-136 cloth as endured 60% of the static flexural strength for 10,000 hours without failure when tested in the standard conditions, but endured only 35% when tested in the wet condition.

Tests of FRP mat, cloth, or woven roving laminates for boat hull construction have not been completed, but limited test data for mat laminates indicates that the strength level probably will be lower. For boat

Table 3. Panel Impact Resistance, Wet Condition, of Fiber Glass-Reinforced Polyester Laminates*

Molding Method & Reinforcement	Number of Plies	Nominal Glass Content, Percent	Thickness, Inches	Weight, Lbs./Sq.Ft.	Impact Test Data: Weight of Striker, Lbs.	Impact Test Data: Height of Drop, Ft.	Impact Test Data: Strength Foot-Pounds
Contact:							
22-oz. Woven roving Rigid resin, 100%	12	51.6	0.435	4.22	72	15	1,080
22-oz. Woven roving Rigid resin, 90% Flexible resin, 10%	12	51.6	0.475	4.22	82	15	1,230
22-oz. Woven roving Rigid resin, 90% Flexible resin, 10%	15	45.8	0.565	4.54	77	15	1,155
26-oz. Woven roving 1/4-oz. Mat Rigid resin, 100%	7 8	39.5	0.450	3.78	52	15	780
26-oz. Woven roving 1/4-oz. Mat Rigid resin, 90% Flexible resin, 10%	7 8	33.5	0.490	3.78	57	15	855
26-oz. Woven roving 3/4-oz. Mat Rigid resin, 100%	7 8	36.2	0.570	4.78	62	15	930
26-oz. Woven roving 3/4-oz. Mat Rigid resin, 90% Flexible resin, 10%	7 8	37.7	0.540	4.55	72	15	1,080
Vacuum Bag:							
1 1/2-oz. Mat Rigid resin, 100%	12	40.8	0.355	3.34	32	15	480
1 1/2-oz. Mat Rigid resin, 90% Flexible resin, 10%	12	41.3	0.380	2.89	37	15	555
3-oz. Mat Rigid resin, 100%	6	33.4	0.435	3.11	32	15	480
3-oz. Mat Rigid resin, 90% Flexible resin, 10%	6	33.7	0.420	3.00	37	15	555
Autoclave:							
2-oz. Mat Rigid resin, 100%	15	48.9	0.431	3.90	42	15	630

*Maximum allowable leakage through impacted area under a two-foot water head specified at three gallons per hour.

hull applications in which load is to be carried for long periods, stress-rupture should be considered in the design.

In general, glass mat laminates have good strength and moduli and, if molded carefully, should have uniform properties regardless of contour or direction. When subjected to impact or tensile loading, mat laminates have little tendency to delaminate, but have poor resistance to repeated impacts.

Glass cloth laminates are dependent on the thickness and construction of the cloth used. In general, strengths of cloth laminates will decrease with increasing cloth thickness, while impact resistance increases. Although cloth laminates have high strengths and impact resistance, they tend to delaminate during impact and tensile loading due to their poor resistance to interlaminar shear. The principal disadvantage of cloth laminates, regardless of construction or thickness, is their relatively high cost per pound when compared with mat or woven roving laminates for large-scale structural applications. In addition, the lighter weight cloths that have better laminate properties are more expensive to cut and lay-up than heavier weight mats or woven roving because of the greater number of plies required for a given laminate thickness.

Table 4 indicates that the materials cost disadvantage is particularly apparent when a typical cloth laminate is compared with a mat or woven roving laminate

Table 4. Comparison of Material Costs of Typical Laminates of Equal Rigidity*

Characteristics	1000 Cloth	2-oz. Mat	Cloth: Mat Ratio	Woven Rovings	Cloth: Rovings Ratio	Mat: Rovings Ratio
Modulus of Elasticity**	1,960,000	1,380,000	1.42	1,810,000	1.08	0.753
Glass content, %**	48	48	——	50	——	——
Comparative Thickness, in.	0.25	0.28	0.89	0.26	0.96	1.08
Number of plies of reinforcement	16	10	1.60	6	2.67	1.67
Laminate weight lbs./sq.ft.	2.0	2.25	0.89	2.08	0.96	1.08
Weight of glass, lbs./sq.ft. of laminate	0.98	1.08	——	1.04	——	——
Cost of Silane-finished reinforcement, $/lb.	1.10	0.63	1.75	0.70	1.57	0.90
Cost of reinforcement, $/sq.ft. of laminate	1.08	0.68	1.59	0.73	1.48	0.93
Cost of laminate, $/sq.ft.	1.49	1.15	1.30	1.14	1.31	1.01

**Modulus, elasticity, and glass content from Table 2.
*Cost of resin mix—40 cents per pound.

on a basis of equal rigidity. This comparison indicates that the mat- or roving-reinforced laminates are approximately 30% less expensive than the cloth-reinforced laminates without consideration of the additional labor economy of fewer plies of reinforcement to cut and lay-up. The cloth laminate, however, is slightly thinner than the mat and woven roving laminates for equal rigidity. For many applications, this difference in thickness and the resultant saving in weight are important advantages of the fabric-reinforced laminates.

Woven roving laminates, in general, have high strength and moduli properties, as well as high impact resistance. Due to the spacing of the weave in woven roving reinforcement, resin-rich areas tend to form on the surface and between the layers, reducing the laminate resistance to weathering and crazing. The higher base weights of woven roving tend to minimize lay-up costs due to the low number of plies required for a given laminate thickness.

The concept of composite laminates having alternate plies of mat and woven roving is that high strengths and moduli will be derived from the roving, while the mat between the plies of roving increases the interlaminar shear strength. This higher interlaminar shear strength will aid in resisting delamination due to impact or tensile loading. Scattered test data indicate that composite mat and woven roving laminate strengths are lower than might be expected on the basis of physical tests of laminates of woven roving alone.

It is reasonable to assume that composite reinforced laminates do not resist loading uniformly because the woven roving layers may reach high stress concentrations before the mat layers because of the higher modulus of the roving reinforcement. The results of this uneven loading may be progressive failure of the laminate at lower strength values than those which could be obtained with layers of similar reinforcement acting in unison. Satisfactory composite laminates usually consist of several layers of mat or woven roving with a single layer of No. 1000-150 style cloth on each face. These additional layers of cloth reinforce the resin-rich surface areas and improve resistance to marine weathering.

Stiffening frames for FRP laminates in boat hull construction usually are of the same reinforcement as the hull skin laminates. Where high strength and moduli are needed, style No. 1000-150 cloth and unidirectional roving laminates are considered to be superior. Cloth reinforcement has greater drapability and can be molded easily over stiffening cores, thus reducing resin-rich areas at the corners.

Although testing of specimens of specific laminates provides much needed physical property data, these test results may not be representative of an exact duplicate laminate in a boat hull, since shape and continuity provide additional inherent strength.

(*Continued in December*)

High-Speed Tensile Tests of Thermoplastics

(*Continued from page 901*)

Powder Co., Wilmington, Del. (1954).

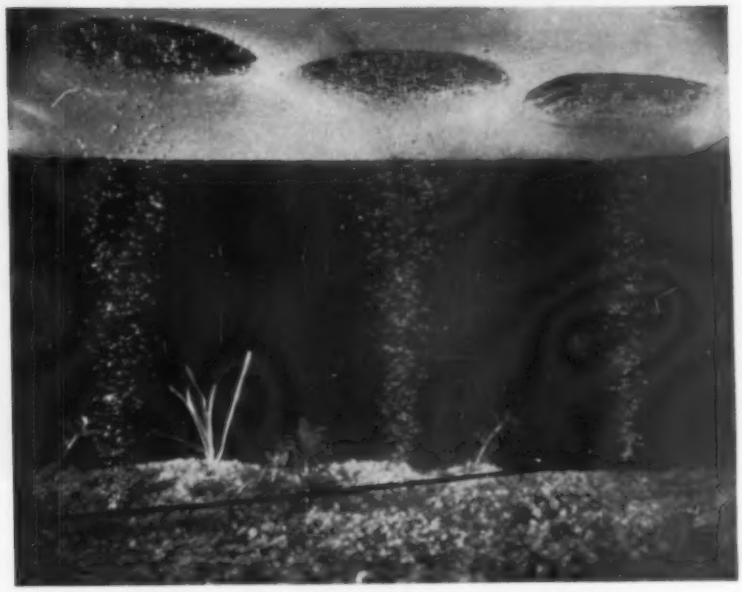
(14) "High-Speed Tension Testing Machine for Plastics," J. Dorsey, F. J. McGarry, and A. G. H. Dietz, **ASTM Bull.**, No. 211 (1956).

(15) "Design and Test of a Rapid-Loading Universal Testing Machine," R. G. Gaumer, Tech. Memo No. 1082, U. S. Naval Ord. Test Station. (1954).

(16) "Description and Performance Data for a Pneumatically Operated Rapid-Rate Tensile Machine," Ordnance Missile Laboratories, Redstone Arsenal, Huntsville, Ala. (1956).

(17) "The Tensile Impact Properties of Some Plastics," B. Maxwell, J. P. Harrington, and R. E. Monica, Tech. Rpt. No. 24A, Plastics Lab., Princeton University, Princeton, N. J. (1952).

—THE END



Laboratory demonstration of how compressed air escaping from perforated polyethylene pipe brings warmer water to the surface and melts ice.

Solves Ice-Locking Problem

ICE that keeps ships locked in slips all winter and locks log-ponds no longer presents a problem, thanks to the tailoring of a Swedish experiment to Canadian needs. The scientific principle behind the operation is quite simple. Water reaches its maximum density and lies at or near the bottom of a lake or river at 39.2° F. Air bubbles blown through non-corrosive, perforated polyethylene pipe brings this relatively-warm water to the surface, thus melting ice and preventing its re-formation.

Atlas Copco Canada, Ltd., Canadian representatives of a Swedish manufacturer of compressed air equipment, worked in cooperation with Canadian Industries, Ltd., to keep the boats of Prescott & Ogdensburg Ferry Co., floating in open water. They ran 40-foot lengths of the perforated pipe beneath the ships' sterns; 70-foot lengths underneath either side; and a 170-foot length beneath the keel. All were anchored a foot from the bottom of the slip, and were connected to a polyethylene line running from the Atlas compressor on the dock.

Pipe holes were 1/32-inch in diameter, and were spaced every six feet along the 3/4-inch pipe. Actually, hole spacing varies with the depth of the water, and one bubble stream will keep a patch of water open, equal in diameter to the depth from which the bubbles rise. Eight-pound weights every 12 feet served as anchors.

Foot-thick ice around the ferry boat was melted in three days. The action of "warm" water on the ice around the ship, plus the currents on the open water, combined to clear the entire 4,000 square-foot slipway. Success was reported also at Celgar, Ltd.'s log-pond in British Columbia.

—THE END

Causes and Control of Calender Roll Plating of Vinyl Compounds

(*Continued from page 891*)

(3) Chelating agents (organo phosphites), when used with barium-cadmium stabilizers in conventional concentrations, have no significant effect on the degree of roll plating, although abnormally high concentrations significantly reduce roll plating.

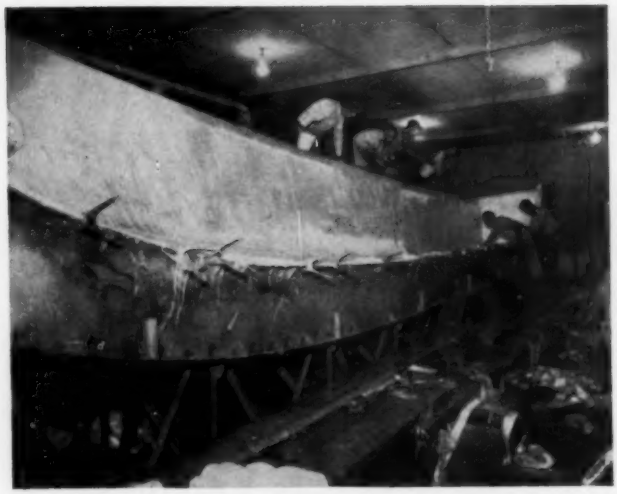
(4) Pigments such as lead chromates and the phthalocyanines are partially soluble in the plating components and increase roll plating.

(5) Vinyl resins tested did not appreciably alter the degree of plating.

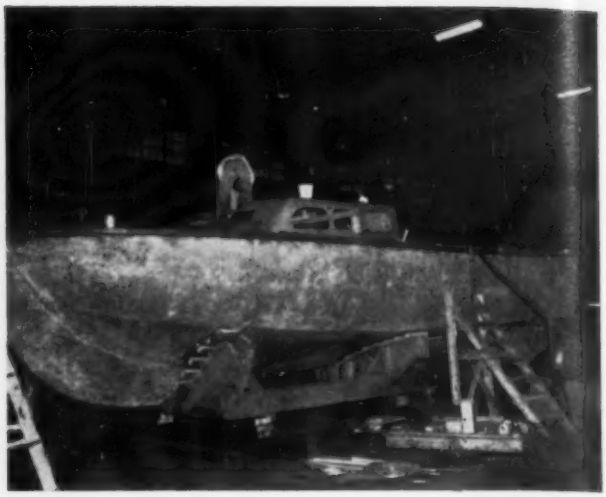
(6) Fillers reduce plating because of their scrubbing action. "Silene" EF and "Hi-Sil" 110 are particularly effective.

(7) Stearic acid, a lubricant, significantly reduces roll plating.

As a result of the information gathered from the calender roll plating test, it now is possible to formulate compounds that are either non-plating or show reduced plating tendencies. —THE END



Starboard section of LCP hull under construction.



Boat parts are assembled prior to finishing.

LCP reinforced plastic craft features maneuverability.

Reinforced Plastic Patrol Boat

A patrol boat for the U. S. Navy, featuring one of the largest reinforced plastic hulls ever constructed, has been molded by Universal Moulded Products Corp., Bristol, Va. Known as the LCP (L)-Landing Craft Personnel, the craft is over 40 feet long. The beam is 12 feet, including guard, and the single-screw planing hull craft weighs 19,000 pounds.

A high-speed model, the boat has a high degree of durability and maneuverability. It is said to have a service life 50% greater than similar wood or steel craft. Hetron, a fire-retardant polyester resin produced by the Durez Plastics division of Hooker Electrochemical Co., was selected by Universal as the binding agent due to its high-strength values with either mat- or cloth-reinforced materials and its flame resistance.

The basic hull is a single-skin, transversely-framed unit made in three longitudinal sections: port, starboard, and center. This reportedly gives a much stronger central inside flange, which forms the backbone of the boat. In the usual method of laying-up and molding, the hull is made as a single unit with flanges added as a secondary operation. This is a very cumbersome method, and involves scaffold work and confined spaces.

The framing consists of a layup over foamed cores. The frame templates are finished off with two strips of material, forming a box in the shape and contour of the frame core. These core boxes are filled with an isocyanate foaming material to cast the frame cores to shape. This foam was found to withstand the solvent action of the liquid resins, the high temperatures involved during exotherm, and the pressures required in molding.

Deck and bulkheads of the LCP (L) are of honeycomb construction. They are formed by laying-up the first skin on the mold, putting paper honeycomb in place, filling-in local areas with bolt-reinforcements and the like, and then applying the top skin. The deck was made in two transverse sections for ease of handling and engine repair. Bulkheads were made singly and shaped to fit the hull.

Deckhouse, deckhouse hatch, and the three-section engine room hatch are single-skin constructions formed by the vacuum-blanket process. Layups are made with woven-roving glass fiber and Hetron 92 polyester resin. The design practices, engineering, and materials of contruction are readily adaptable for use in such civilian applications as workboats, large runabouts, and cabin cruisers. The Universal process for mat-laminates is said to give more than 50% glass content.

—The End

Moldmaking & Tooling

Comments on mold costs

Edited by: ERNEST J. CSASZAR, *Sales engineer,*
Newark Die Co.,
Newark, N. J.

IN the early stages of discussing an anticipated molding venture, the mold requirements are explored. Prominent in the over-all cost picture is the amount of money needed to purchase a mold. This is true for two reasons: first, it is an initial expenditure involving a rather lengthy waiting period before returns on the investment are realized; and second, it usually is a sizeable sum. When the mold is for an item of untested sales appeal, an element of risk exists as to whether or not the investment can be recouped. There are, no doubt, many other reasons why mold costs are discussed and, after a tone of controversy creeps into these discussions, the moldmaker often is asked why molds cost so much.

Before we try to answer this question, let us realize that mold cost is a relative item. The cost of a mold usually is presented as a lump sum figure. If we consider the number of parts to be produced from this mold, the picture soon changes. When the anticipated production from a single mold is small, then the mold cost per unit of items produced is usually high. On the other hand, if production requirements are great, then the mold-cost portion of the piece price may become negligible. It is readily seen, by this type of reasoning, that the same lump-sum mold cost figure can be looked upon as being either high or low, depending upon the ultimate production requirements.

Let us go back to "high mold cost" statements and examine some of the items of expenditure that go into mold construction. First, we have the cost of materials from which the mold is constructed. Material cost is a rather stable and constant figure throughout the country and, except in unusual cases, represents only a small portion of the total mold price. For all practical purposes, we can disregard it as a factor in the high cost of molds. Engineering time, too, usually accounts for only a small portion of the total cost. It remains then, that the major part of mold cost is represented by construction labor. In point of fact, it is often said that mold makers do not sell molds, but labor and knowledge of moldmaking techniques.

Almost all molds are custom-made items. In other words, practically every new mold is designed for a product which has not been made previously. The construction of a mold, therefore, always presents a new set of production problems. While it is true that each mold is different, there are elements of construction which are similar from mold to mold. This similarity alone, however, is not enough to enable the moldmaker to take full advantage of mass production and time-saving activities.

Present day mold requirements dictate close tolerances, automatic actions, smooth mechanical function, and close adherence to delivery schedules. These elements cannot always be spelled out in mold designs and specifications. As a matter of fact, a large amount of supervisory follow-up is required to achieve these functions successfully. Supervision is costly, but cannot be eliminated without serious danger of quality loss and delivery performance. This supervisory cost must be reflected in the mold price, even though it is not a matter of direct labor hours applied to the job.

The second question often asked of moldmakers is: "Why do I get such a wide variance in mold cost quotes?" Here again, we have a number of factors which can give us a considerable difference in mold prices quoted by different suppliers. This does not necessarily imply that some are in error in their estimates. All too often the inquiry for a mold price is a simple request for, let us say, a six-cavity injection mold. No further mold specifications or details are given.

(*Continued on page 914*)

Reinforced Plastics

Standardization of resin data

Edited by:
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Huntington Station, N. Y.

THE vast number of similar resins on the market, often available from the same supplier, is one of the many factors which keep resin prices high. A step towards lowering these prices would be the concentration by the various suppliers on two or three good, thoroughly-tested resins for certain specific jobs. At present, the introduction of new resins is accompanied by technical data sheets and promotion literature which generally are too numerous to read and, more often than not, too vague to follow.

Valuable time is spent by the reinforced plastics molder in reading inadequate data, talking with inexperienced salesmen who cannot supply the needed information, and trying resins which perform poorly, however carefully the directions are followed. The following are just some of the problems along these lines which have plagued the reinforced plastics molder:

"General purpose" resin is not an adequate description. A general purpose resin produced by one manufacturer can be radically different from one produced by another supplier. Since production runs are based on definite know-how, the term "general purpose" can cover a multitude of sins by its vagueness.

We have found resins whose viscosity was as thin as water at 70° F. Others were as thick as grease, and several differed in viscosity by 20%. Salesmen should have brief, factual data cards compiled by the supplier, and listing the important test points as determined by standard tests. Such resins should then react the same under duplicated conditions. Unfortunately, reinforced plastics molders rarely have the facilities or the budget for experimentation.

Viscosities and their significance should be indicated clearly by the supplier. Expensive parts have been ruined because the technical data supplied by the manufacturer was inadequate. Some resins will differ in gel time from batch to batch.

How "rigid" is rigid? What is meant by "resilient?" Looking at some of the data sheets, I see words like "semi-rigid," "flexible," and "elongation." What one supplier calls rigid in a general purpose resin, can turn out to be quite the opposite in another's product.

A few suppliers do issue comprehensive data sheets, but many are unwieldy and involve several folded pages opening up like a road map. Other manufacturers regularly send data sheets to fill or replace obsolete sheets in a previously-sent folder. Should these be lost in the mail, or should a secretary prove negligent in inserting the new sheet, the latest information is not available.

At Lunn Laminates, we have devised a physical-data wall chart to coordinate all our own test data. This chart saves time, obviating the need for wading through files for literature on a specific resin. This is a costly procedure, but we genuinely felt the need for its establishment.

Perhaps our work along these lines might be of assistance to other molders. We make our mold tests in the lab from a five-gallon sample can, ascertaining the resin's speed, toughness, freedom from crazing, and the like. The next step is a production step, and the final one involves correlation of data and recommendations to the engineering, production, and purchasing departments. —THE END

Mold Making & Tooling
(*Continued from page 913*)

This is practically the same as asking a builder for quotes on a six-room house. Without exact specifications, any number of prices can be equally correct depending upon the type house the builder envisions. Many of these differences in bids can be lessened if specifications are spelled out more carefully. Sketchy information leads the moldmaker to quote a safety factor, thus covering himself against additional, unforeseen amounts of work.

Many of the smaller mold shops cannot afford cost systems. Not knowing their exact costs handicaps them with respect to giving accurate estimates. In these cases, the human element plays too large a part in the cost estimate, thus allowing for wider differences in price quotations. Slowly but surely, wider experience, severe competition, salesmanship, and high production volume are correcting many of these differences. —THE END

Edited by:
JOHN H. WOODRUFF, *President,*
Auburn Plastics, Inc.,
Auburn, New York

Compression & Transfer Molding

The captive and the custom molder.

MR. Oberle's letter which appeared in this column in July was a pretty general indictment of the custom compression molders. From the tone of this letter it appears that we have had our heads in the sand for the last few years. Since I do not believe this to be true, and further, as none of the custom molders have given me any comments on his statements, I would like to state the custom molders' position as I see it.

First, a good many custom molders who, according to Mr. Oberle, *are* expanding and modernizing in injection molding also have compression plants which they are not re-equipping. Why? The answer, I believe, is related to the difficulty in obtaining capital and the potential return on the investment. Injection molding is gaining rapidly and it is relatively easy to forecast large sales gains, while compression is more nearly static. The molder is, therefore, much more likely to invest his limited capital in his injection department.

Secondly, I feel that cost analysis made by the captive companies, based on automatic molding, show up many savings which cannot be attributed merely to automatic molding. The custom molder provides many expensive services—sales, estimating, engineering, purchasing, mold repair facilities, quality control, shipping, etc. which appear in his costs but not in the captive companies' molding cost study. The actual direct savings contributed by the automatic press are the operators' wages. Automatic presses are very expensive and the depreciation and interest on the investment approach the operators' wages. There are other indirect and hard to measure savings arising from more uniform quality, but to offset these we have found press and mold maintenance costs to be considerably higher, and the operator is frequently able to perform some finishing operations.

Thirdly, the custom molder sees two distinct disadvantages to the automatic press—lack of flexibility and lack of suitable jobs. The custom molder runs a very wide variety of parts, made from many different materials, and frequently containing inserts. The high volume, general purpose moldings without inserts probably belongs in the captive shop, and this I believe explains Mr. Oberle's success in selling to the captive molders. Our customers are becoming more critical as to tolerances and it is now an exceptional part which does not require a cooling fixture.

There definitely are many parts which should be molded on automatic presses, but over-all economics dictate that the customer mold them himself. Consequently the average custom molder does not see many inquiries for parts of this type and is, therefore, naturally loath to make the large investment necessary for a battery of automatics. Furthermore, the molders' profit margin is now extremely low and can only be increased by adding more value to the molding compound before it is shipped. Automatically molding 20¢/lb. material, tumbling, and selling at the equivalent of 30¢/lb. is not the answer to profits and a healthy industry.

The September issue of "British Plastics" carries a very interesting article on rapid preheating of phenolic materials, showing cures reduced to one-tenth the time required with cold preforms and one-fifth the time with conventionally preheated preforms. There is also a rather pessimistic editorial on the future of phenolics.

—THE END

News of the Societies

SPI Cellular Plastics Conference

More than 300 members and guests gathered at the Hotel Commodore in New York City to attend the second annual conference of SPI's cellular plastics division. Held on October 16, the all-day meeting was arranged to highlight the present and potential uses of "Cellular Plastics in House and Home."

Henry E. Allen, Elastomer Chemical Corp., served as chairman of the morning session. The first speaker, Leon Talalay, B. F. Goodrich Sponge Products Division, B. F. Goodrich Co., discussed "Properties of Cellular Plastics Materials." Predicting a rapid increase in the consumption of these products, Mr. Talalay went on to summarize the basic properties of both flexible and rigid types. In the flexible category, he recommended specific applications such as comfort cushioning, sound and shock absorption, and heat insulation. He also outlined performance data on tensile, elongation, tear, and flexing properties. In dealing with rigid foamed materials, he discussed densities, compressive strengths, heat distortion temperatures, and water-absorption characteristics; concluding with a summary of specific structural properties.

"The Use of Cellular Plastics to Protect the Family" was the subject of the address given by Edward R. Dye, Cornell Aeronautical Research Laboratory, Inc. Mr. Dye compared the relative number of deaths occurring in different types of accidents, and pointed out that in aircraft and automobile mishaps, about 75% of the fatalities are the result of head injuries. He discussed the findings of the Cornell Aeronautical Laboratory's research into the energy levels of brain-damaging blows, and suggested that a suitable cellular plastic padding would be the answer for head-to-floor contact problems. Based on the laboratory's head-impact investigations, a satisfactory protection rug pad should be ¾-inch thick; should have a density of not less than 10 pounds per cubic foot; and should exhibit a resistance such that a pressure of 40-50 psi. would be required to compress it 3/16-inch. The material should be of the energy-absorbing rather than energy-restoring type; and should be odorless, washable, low in cost, and resistant to decay, and vermin.

"Cushioning and Bedding Applications of Cellular Plastics" was discussed by Ephraim Freedman, Macy's Bureau of Standards, R. H. Macy & Co., Inc. He covered the desirable physical properties of cellular-plastic cushioning materials and dwelt on the corresponding characteristics of the various natural fibers currently in use. He stressed the need for accurate terminology in labeling, and summarized many of the pertinent rules and definitions recently adopted by the New York State Department of Labor's bedding division.

The closing discussion for the morning session, given by Ivan H. Schwartz, Thermatron Division, Radio Receptor Co., Inc., dealt with "High Frequency Welding of Cellular Plastics." Mr. Schwartz defined the dielectric heating process and explained that heat is generated by molecular friction resulting from their periodic displacement under the influence of high frequency electrical energy. Considerable economies are possible with the use of high frequency welding equipment, since the articles can be fabricated directly from a sheet of slab stock. In this type operation, cushioning, covering, cutting, and embossing can be accomplished simultaneously. High frequency equipment manufacturers have instituted many types of automatic and semi-automatic materials handling equipment, thus reducing the amount of time, space, and labor involved as well as improving product quality. A good, weldable foam will weld not only to itself but to vinyl film and sheeting, or even vinyl supported fabrics. Some of the non-weldable foams have been used in conjunction with high frequency heating processes by being imprisoned between two welded vinyl sheets. Excluding automotive applications, it is estimated that 4-million board feet of foam were formed into welded products last year, and this figure is expected to double itself this year.

Session chairman for the afternoon program was Edward A. Edberg, Dylite Division, Koppers Co., Inc. Immediately following luncheon, Ralph J. Johnson, director, Construction and Research Institute, National Association of Home Builders, discoursed on "Cellular Plastics in House Construction." Three fundamental changes which have occurred over the past 20 years, altering the character of the home building industry have included: development of F.H.A. and V.A. programs to provide a guarantee to the lender; construction of houses for unknown buyers; and the introduction of new materials for construction. He pointed out that while more medium priced houses are available, medium income buyers are not. As a result, the industry is striving for cheaper materials and more efficient methods of construction. He criticized the lack of modular dimensioning and coordination, and held that the use of component parts, such as simplified structural elements; newer heating and cooling equipment; and the use of glues in structural applications would lead to an economical solution. Mr. Johnson indicated that cellular plastics could provide an answer to the problem and gave examples of the desirable physical properties of exterior, modular wall paneling.

The applications of "Cellular Plastics in New Home Design" were examined by Harold D. Hauf, Dean of the School of Architecture, Rensselaer Polytechnic Institute. Mr. Hauf discussed the factors in house construction that are leading to an industrialization of the process, and their relationship to the development of a market for cellular plastic materials. Foamed plastics should be used in a manner that would utilize their inherent properties to the best advantage, rather than attempting to provide a substitute for, or imitation of, conventional materials. A trend toward panelization implies the use of prefabricated panels assembled at the building site. Coordinated dimensions and components that fit together without cutting and patching, are the only concepts in sight that will permit housebuilding in general, and small builders in particular, to obtain some of the benefits of mass production. Design and construction must be integrated so that work at the building site will consist only of an assembly operation.

F. R. Marshall, Refrigerator-Freezer Engineering Dept., Westinghouse Electric Corp., spoke on "Cellular Plastics in Appliance Construction." With the use of cellular plastics, refrigerator insulation is available which not only acts as a heat barrier, but adds structural strength to the refrigerator itself. In the appliance field, a sandwich cabinet with cellular insulation can be produced for approximately ⅛ the cost of tooling a conventional refrigerator cabinet. Mr. Marshall described in detail a refrigerator whose component panels were made from an inner and outer plastic skin, laminated to a plank of rigid foam. While the material under consideration was styrene, he pointed out that any foamed plastic having desirable insulating characteristics could be used. The biggest failing of some polyurethane materials lies in their tendency to be open-celled. This results in the absorption and transmission of water vapor, with consequent reduction of insulating properties. Public demand for large refrigerators and freezers creates the problem of finding enough space to install them in the home. A large amount of usable space could be obtained by reducing the thickness of the insulation, but at present no sufficiently-good insulators are available at a cost that would permit their use in mass produced units.

Wire and Cable Symposium

The sixth annual Wire & Cable Symposium will be held at the Berkeley-Carteret Hotel in Asbury Park, N. J., on December 3-5. Sponsored jointly by the U. S. Army Signal Engineering Laboratories and industry, the three-day conference will report technical progress during the past year in the field of communication wires and cables. Twenty-five papers will be presented.

The symposium committee is headed by Howard L. Kitts, chief of the outside plant branch of the Communications Department.

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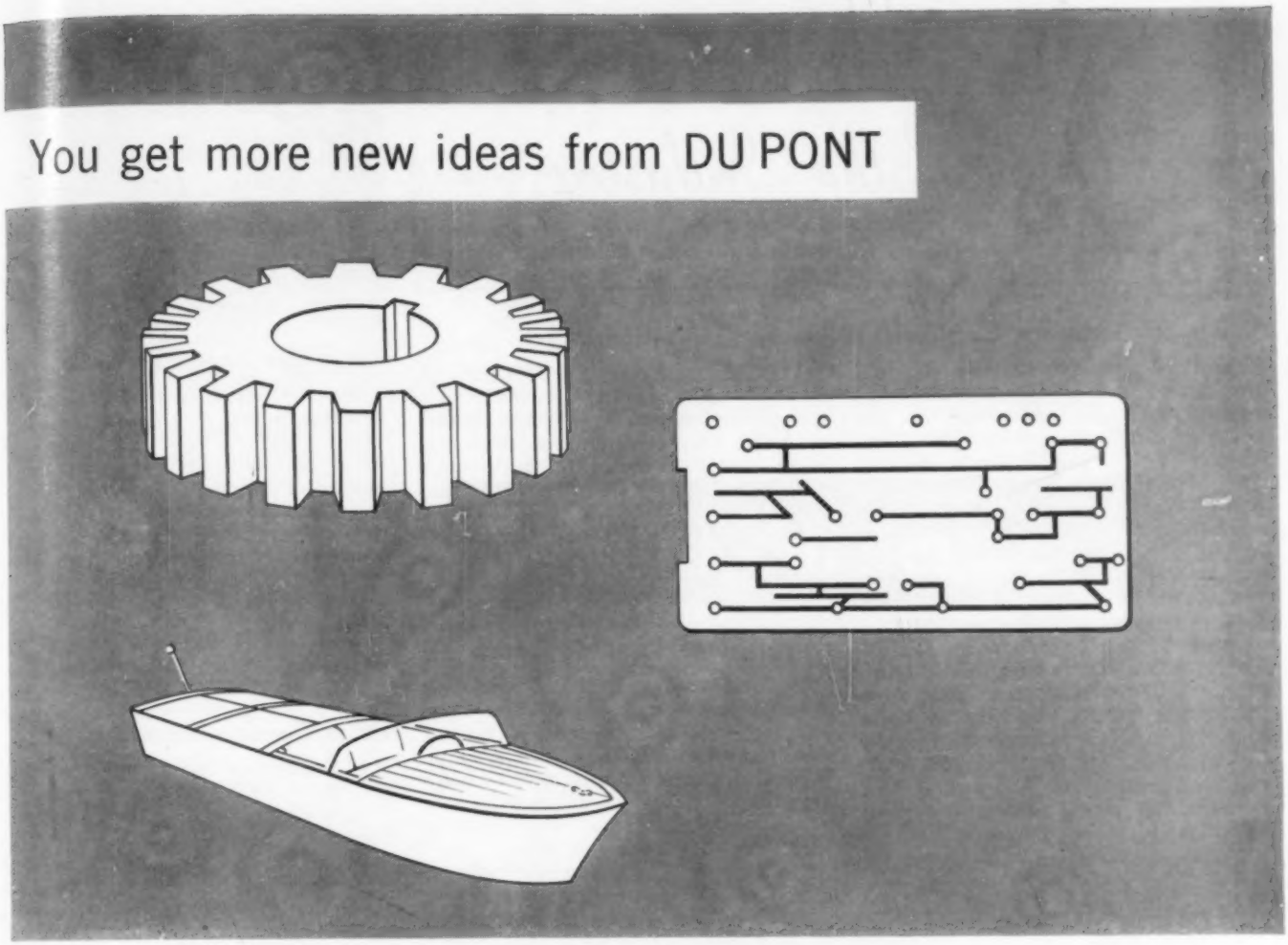

New stabilized MPD S Technical especially designed to give lighter colored, more uniform epoxies

Du Pont m-Phenylenediamine (MPD for short) was one of the first curing agents used for epoxy resins . . . and still is one of the best. Now improved and stabilized and known as m-Phenylenediamine S Technical, this all-around curing agent is hard to beat in making those epoxy resin laminates and castings destined for end-use at high temperatures where color is of prime importance.

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ORGANIC CHEMICALS DEPARTMENT

News of the Industry

Announces Labeling Contest

The third annual contest for the best informative labeling for plastics retail products has been announced by the Society of the Plastics Industry, Inc., New York, N. Y. The contest, whose purpose is to increase retailer and consumer knowledge of plastics, is open to all companies and individuals in the U. S. A. who are engaged in the manufacture or marketing of plastics consumer products. Non-members as well as members of the SPI are eligible.

Entries should be submitted to SPI with, if practical, the product they identify. Awards will be made for informative labeling that tells the consumer what the product is, what it is made of, how to take care of it, and gives a brand name or other identification. The contest will be judged by merchandising authorities and editors, and closes December 1, 1957. Entry blanks will be furnished on request by SPI, 250 Park Ave., New York 17, N. Y.

Opens Western Sales Office

A West coast polyethylene sales office has been opened in Los Angeles, Cal., by Spencer Chemical Co., Kansas City, Mo. The branch will be directed by C. W. Brooks, and will serve California, Oregon, Arizona, and Nevada. In addition, Spencer will maintain warehouse facilities in Los Angeles.

Opens New Jersey Plant

A multi-million dollar plant for the production of Saflex polyvinyl butyral film has been opened in Trenton, N. J., by Monsanto Chemical Co., Springfield, Mass. The facility will more than double the company's output-capacity for the plastic interlayer.

This represents the company's third expansion of its Saflex production during the past four years. Manufacturing capacity at Springfield, Mass., was increased 20% in 1953, and 50% in 1954. Used extensively in the production of safety glass, the material also can be used in decorative laminates for structural applications and in the manufacture of implosion plates for color television receivers.

Names Sales Distributor

Vogt Manufacturing Corp., Rochester, N. Y., makers of clear, flexible, vinyl tubing, has announced the appointment of Nalge Co., Inc., also of Rochester, as its master distributor for both nation wide and foreign sales. The tubing, distributed under the trade name Nalgon, will be identified as a Voplex product.

Polyethylene Reactor Cores

Linear electron accelerators, developing extremely high beam energies, are being used to irradiate polyethylene nuclear reactor cores at Applied Radiation Corp., Walnut Creek, Cal. The completed cores contain 20% enriched uranium oxide, are cylindrical in shape, and are fabricated in segments about one inch thick.

Polyethylene is an excellent neutron moderator, limited only by its low melting point. Electron irradiation, however, causes the molecules to cross-link thus increasing the melting point, tensile strength, and hardness, while decreasing solubility. The process also increases resistance to environmental stress cracking. Each core comprises 10 segments, and to avoid any possibility of a chain reaction during processing, no more than five segments are handled simultaneously. To guard against abrasion during processing and shipment, each segment is wrapped in polyethylene film.

Constructs New Factory

Expanded manufacturing facilities of the Hull-Standard Corp., are being housed in a plant nearing completion near Hatboro, Pa. Production at the new factory will be devoted primarily to the manufacture of a new model transfer molding press. The building also will contain the firm's central replacement-parts inventory for servicing Standard compression and transfer molding presses currently in use.

Melamine Sales Show Increase

A 21.7% sales increase over the first half of 1956 has been reported for the corresponding period this year by the Melamine Council, New York, N. Y. The report was made after a two-day survey of key retail buyers, store owners, manufacturers representatives, and jobbers, attending the National Housewares Manufacturers Association's annual show held at Atlantic City, N. J., July 7-12.

The reported sales increases were in line with an earlier prediction this year which estimated a 20% increase, plus a total gross sales topping $70-million by the end of 1957. Annual sales for 1956 were estimated at $60-million.

Purchases New Building

A 60,000 square-foot steel and concrete building, which will make possible a 150% expansion in the company's productive capacity, has been purchased by Molded Fiberglass Co., Ashtabula, O. Manufacturers of fiberglass-reinforced plastic parts for the automotive, trucking, and transportation industries; the firm reports an 85% business increase in 1956, and expects to gross well over six-million dollars in 1957.

Valve Division Relocated

A $1.5-million industrial valve production plant has recently been opened at Fort Washington, Pa., by Minneapolis-Honeywell Regulator Co. The 120,000 square-foot plant will house manufacturing, research and development, sales, and administrative facilities formerly located at the valve division's old quarters in downtown Philadelphia.

Firm Grants Process License

Ball bearing retainers made from a finely-divided nylon powder known as Nylasint will be manufactured by Barden Corp., Danbury, Conn., under a license granted by Polymer Processes, Inc., Reading, Pa. Barden has designed prototype retainers of Nylasint and now is in the process of field-testing them. The retainers are oil-impregnated, making them desirable for applications requiring minimal lubrication.

Builds Plastics Research Lab

A $50,000 plastics laboratory has been established by Stanford Research Institute, Menlo Park, Calif. The new building houses equipment to fabricate metal-adhesive-metal laminates; facilities for specimen irradiation; a variety of tensile and flexural strength testing devices; weathering and aging equipment; and vacuum and injection molding machines.

A staff of 32 scientists and technicians conduct Stanford's research program which includes synthesis and evaluation of new polymers; study of the effects of high-energy radiation on polymers; synthesis of polymers amenable to improvement by radiation; and the lamination of plastic films to polyester glass laminates.

Rear view of Cary Chemicals' new PVC plant, with monomer relief vents showing in the foreground.

Cary Opens PVC Plant

A $1-million plant for the production of PVC resins has been opened by Cary Chemicals, Inc. Located on a 28-acre tract in Flemington, N. J., the facility currently has a capacity of 12-million pounds annually, but is so designed that production can be doubled or tripled without difficulty.

Planned and constructed by Scientific Design Co., Inc., and its subsidiary S. D. Plants, Inc., Cary's new plant will employ SD's polymerization process which is said to give PVC resins with outstanding electrical properties. Part of the million-pound monthly output will be used by Cary's Milltown plant in PVC compounds for the insulated wire and cable industry.

Argus Enters Second Decade

This year not only marked the tenth anniversary of Argus Chemical Co.'s existence, but saw expansions in the firm's laboratory space, production and inventory facilities, and personnel at the Brooklyn, N. Y., plant. Plans for next year call for the selection of an additional plant site in the Metropolitan New York area, which will be devoted primarily to plasticizer production.

Argus has just developed a polymeric-type plasticizer, Drapex 7.7, which shows considerable promise in the floor tile and upholstery fields. It is reported to feature exceptional resistance to dirt and stain pick-up, especially such items as asphalt, shoe polish, and traffic stains.

Schedules Production Facility

Union Carbide Corp. has scheduled a major chemicals plant, to be located on the Kanawha River near Winfield, W. Va. Products will include ethanol, ethylene oxide, and isopropanol. Approximately 500 people will be employed.

Scheduled for completion in 1960, the plant will be the firm's eighth major production facility, and the third to be located in the Kanawha Valley. Union Carbide Chemicals Co. will operate the plant, which will supply raw materials for further processing at the South Charleston and Institute plants, as well as chemicals for the open market.

Expands Mixing Facilities

A multiple-story mixing facility, capable of producing in excess of 100,000 gallons per month of liquid adhesives, laminating resins, putties, and sealers, has been placed in operation by Narmco Resins & Coatings Co., Costa Mesa, Calif. The project, which increases Narmco's output capacity of these products by 500%, constitutes a major element in the company's five-year expansion program launched in 1956.

The facility was designed by the firm's engineering department and featurs explosion-proof electrical equipment; wall surfaces coated with a fireproof material; an automatically-controlled blower and exhaust system; and ceiling sprinklers. Processing equipment include hot- and cold-jacketed mixing churns, service mixers for processing resins and elastomeric compounds; a resin kettle; a variety of portable propellor mixers; and pebble mills for special mixing.

Part of Narmco's cold mixing facilities showing (left to right): 125-gallon, Sigma blade mixer; 50-gallon, stainless steel jacketed, high viscosity mixers; three 50-gallon service mixers, 100-gallon mixing churn; and a 250-gallon mixing churn.

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Doubles Melamine Output

Expansion plans which will double the company's melamine and urea production capacity at Toledo, O., have been announced by Barrett division, Allied Chemical & Dye Corp. Scheduled for completion by mid-1959, the project is one of several new Plaskon production facilities erected by Allied since its acquisition of the Toledo properties in 1953.

Expands Resin Production

A resin reactor and new materials-handling equipment have been added to the facilities of Archer-Daniels-Midland Co.'s resin plant at Pensacola, Fla. The expansion increases the plant's output by about 50%, and permits the manufacture of alkyd as well as hard, synthetic resins. The entire output is slated for the protective coatings industry in the South.

Plastic Car Aids Research

Engineers at Chrysler Corp., Detroit, Mich., are using an all-plastic model car to check data on structural strength of body shells, underbodies, and other key parts. The unit is six feet long, transparent, and is an exact three-eighths replica of a standard steel automobile.

When weights are attached to either the front or rear end of the plastic chassis, engineers can determine how actual steel frames or parts will react under a similar strain. Then, through a system of mathematical calculations, they can study the effect of any twist, bend, or deflection that might occur. A one-ounce load on the model is equivalent to 35 pounds being applied to a steel car.

A strain gage records the behaviour of Chrysler Corp.'s plastic model car.

Forms Canadian Subsidiary

Witco Chemical Co. of New York City has formed a Canadian subsidiary for the manufacture and sales of industrial chemicals to the plastics, rubber, and paint industries. Offices will be established in Toronto, Ont., and a manufacturing plant will be set up in nearby Trafalgar Township. Officers of the Canadian firm are William Wishnick, president and treasurer; S. M. Freeman, executive vice president; and H. B. Seligman, vice president.

Instron Constructs New Plant

A 25,000 square-foot plant is being built by Instron Engineering Corp., in Canton, Mass. Designed to meet the increased demands for electronic testing equipment, the facility will be given over design and production of universal testing machines and other electronic devices. It will also house the company's administrative and engineering offices. Instron's headquarters are presently located in Quincy, Mass.

Consolidates Two Plants

Two manufacturing plants, formerly located in Camas, and Washougal, Wash., respectively, have been moved into larger quarters in Camas, by Tidland Machine Co., manufacturers of paper mill equipment and pneumatic shafts for unwinding rolled materials.

The structure housing the merged facilities provides 19,820 square feet of operating space, and an additional 1,200 square feet for the engineering department. The building is of steel construction and is illuminated through reinforced plastic glazing.

Buys Custom Molding Division

Acquisition of Hoosier Cardinal Corp.'s Cardinal division in Evansville, Ind., has been announced by the newly-formed Mimosa Corp., Belton, S. C. Major production equipment, obtained through the recent transaction, has been transferred to the new location. The firm will continue custom injection molding, and will assume responsibility for present and future orders from companies which formerly were doing business with the division. Most of the management group and key personnel have been retained.

Plans Allylamine Production

Production facilities for the manufacture of mono-, di-, and triallylamines are being constructed at Martinez, Calif., by Shell Chemical Co. Current research points toward potential uses for each of the chemicals, which have been laboratory produced for some time. Monallylamine shows promise in the manufacture of resins, surface active agents, and rubber chemicals; diallylamine lends itself to the preparation of rubber chemicals; while triallylamine can be used as an intermeriate in the production of quaternary ammonium compounds.

Receives Process Patent

A continuous process method for the production of translucent Fiberglas building panels has been patented by Filon Plastics Corp., El Segundo, Calif. The patent covers an electronically-controlled manufacturing technique which incorporates the use of nylon parallel strands to assure an even dispersion of glass fibers throughout the panel. This results in uniform thickness and color, plus greater strength.

The process currently is licensed for production in Germany, Italy, France, Belgium, Holland, Luxembourg, and Spain, as well as all markets of the British Commonwealth. Negotiations for further licenses are pending in other foreign countries, and are being handled by the firm's international subsidiary, Filon AG, Zurich, Switzerland.

Builds Acrylonitrile Plant

Construction of an acrylonitrile plant is scheduled to begin early next year at Dow Chemical Co.'s Texas division, Freeport, Tex. Completion of the facility is expected in December 1958, and production will start during the first quarter of 1959.

Schedules Adhesives Plant

A $400,000 plant for the production of adhesives and coatings, is being built by Borden Chemical Co., Canada, Ltd., Toronto, Ont. The building will provide 17,000 square feet of floor space and will accommodate manufacturing facilities, a laboratory and offices. An adjoining tank farm will store supplies of solvents, plasticizers, and asphalt.

Sponsors Research Program

A research program to investigate the behaviour of lithium and its compounds in polymerization reaction, is being sponsored by the American Lithium Institute, Inc., Princeton, N. J. The project will be directed by Professor Arthur V. Tobolsky of Princeton University's chemistry department.

Lithuim and its compounds will be used experimentally as initiators and modifiers in vinyl polymerization and copolymerization. An intensive study will be made of the rates, molecular weights, and copolymer compositions of these materials.

Reorganizes Export Channels

An international department which will be responsible for foreign marketing of carbon blacks, clays, inks, rubber chemicals, and pigments, has been formed by J. M. Huber Corp., New York, N. Y. The department will handle overseas licensing arrangements, and will expedite customer service abroad.

In Brief . . .

Cadet Chemical Corp., has adopted a non-electrostatic, polyethylene-lined paper bag for packaging both wet and dry benzoyl peroxide.

Cadillac Plastic & Chemical Co., has opened a warehouse-sales office at 2546 Irving Blvd., Dallas, Tex. Ernest Dourlet was named branch manager.

Tamms Industries Co., has appointed D. B. Becker Co., its sales representative in the New York City area. Industries served by Tamms include paint, polish, plastics, rubber, and buffing.

W. R. Grace & Co.'s Cryovac division has added a customer award feature to its national direct-mail program. Meat, fish, and poultry customers will receive awards based on successful combination of a quality product, modern production methods, complete packaging program, and outstanding merchandising support. A fifth award will be given each month to the customer whose story appears in Cryovac's external house organ, Marketing Q's.

Resistoflex Corp., has named Eastman Atlantic Mfg. Co., Atlanta, Ga., as a warehousing distributor of hose and hose assemblies in Alabama, Georgia, and Florida.

R. S. Aries & Associates has moved to new and larger quarters at 77 South St., Stamford, Conn.

M. A. Ford Mfg. Co., Inc., has moved to larger quarters at 1545 Rockingham Road, Davenport, Ia. The firm makes H.S.S. and carbide rotary cutters and countersinks, carbide end mills, and special tools.

A. J. Passono Co., Bellair Beach, Fla., will serve as manufacturer's representative for Diamonite Products Mfg. Co., in five southern states. The high-alumina ceramic grinding rods are used in the paint, plastics, chemical, and rubber fields.

Wallace Silversmiths, Ltd., Canadian branch of the Wallingford, Conn. corporation of the same name, has acquired General Plastics, Ltd., Toronto, Ont. The latter firm manufactures plastic housewares and Melmac dinnerware.

Nuclear Systems, division of Budd Co., has announced reductions in the price of cobalt 60 ranging from 50-70%. These reductions hold for all sources up to 50,000 curies.

United States Rubber Co., has introduced a new line of textured Elastic Naugahyde vinyl upholstery called Coven. Eight multiple-print colors are available in 54-inch widths: coral, gray, mocha, olive, cerulean, lemon, cantaloupe, and green.

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Names in the News

Edwin H. Ahlefeld, Jr.

Edwin H. Ahlefeld, Jr., has been named to head up the rubber & Plastics division of Farrel-Birmingham Co., Inc. He will direct sales and engineering of the firm's processing machines, which are used in both industries.

Joseph W. Mackenzie was elected secretary, and **George R. Beck** assistant treasurer, at a recent meeting of the board of directors, Plumb Chemical Corp., Philadelphia, Pa.

Clifford A. Neros has been appointed group leader in the product development section, central research department, Diamond Alkali Co., Cleveland, O. From headquarters at Painesville, O., he will continue to direct laboratory work relating to chemical and plastics product evaluation.

Monsanto Chemical Co., St. Louis, Mo., has announced the assignment of new personnel to various departments within its plastics division. Appointees include: **David E. Schoeffel, Harry R. Littleton,** and **Charles R. Ellicott III;** to research, Lustrex, and advertising, respectively, at Springfield, Mass. Joining the divisional facilities at Texas City, Tex., **Donald G. Mayo** has been assigned to production, and **John E. Hays** to engineering.

J. C. Burkholder has been appointed assistant to the manager of Archer-Daniels-Midland Co.'s resin and plastics division. He formerly served as manager of the Atlanta regional office. **Fred Burnett,** former sales manager for industrial resins, becomes manager of product and sales planning for that division. **Earl Erlandson,** Chicago regional sales supervisor, becomes Atlanta sales manager. **A. Eugene Koehler** replaces Mr. Erlandson, and **Floyd Nelson** has been named regional resins sales supervisor for the Minneapolis, Kansas City, Dallas, Houston, New Orleans, and Memphis territories. **Burton W. Schroeder** and **John H. Daniels** have been elected vice presidents. **Richard M. Benton** and **Gordon Bader** have been named technical sales representatives. **Eugene L. Bulgozdy** has been named manager of the newly-created Detroit sales office, and **Gerald C. Berry** has been appointed to his sales office.

William H. Kibbel, Jr., has been named to the newly-created position of market research manager for Becco Chemical Division, Food Machinery and Chemical Corp., Buffalo, N. Y. **Vernon E. Moore,** former sales representative, has been promoted to manager of the firm's West Coast territory.

J. G. Carden, sales representative for Owens-Corning Fiberglas Corp., has been transferred to the firm's New York office from Washington, D. C.

Robert D. Weant has been appointed sales representative for Plaskon industrial adhesives, Barrett division, Allied Chemical & Dye Corp. His territory will be Virginia and North Carolina.

Edward L. Carlson, advertising manager of Oakite Products, Inc., has been placed in over-all charge of the firm's information service, including trade shows, direct mail, and publicity. He will continue to direct the firm's advertising program.

Robert L. Purvin

Robert L. Purvin has been elected executive vice president of Foster Grant Co., Leominster, Mass. He most recently served as president and director of Purvin & Gertz, Inc., a petrochemical consulting firm.

Roland Whitehurst

Roland Whitehurst, vice president and a director of Electric Storage Battery Co., has been elected president of Jessall Plastics Inc., a wholly-owned subsidiary. He will continue to head up the Exide Industrial division in Philadelphia. **Monroe G. Smith,** comptroller, will take on Mr. Whitehurst's former duties as general manager of that division. **William C. Leingang,** former assistant to the president, has been named general manager of the Stokes Molded Products division.

James M. Church, professor of chemical engineering at Columbia University, has been elected a director of Riverside Plastics Corp. Prior to his return to academic work, Dr. Church spent eight years with the organic chemicals division of Monsanto Chemical Co. He also spent a year with Du Pont's polychemicals department.

Victor E. Serrell has joined the Rochester, N. Y., manufacturers' representative firm of Beach Plastics, Inc. For the past 12 years he had been a Bakelite field engineer.

Howard Gamble has been appointed to the New England field sales staff of F. J. Stokes Corp.'s press division. He formerly served as assistant to the manager of engineering at Bachman Bros.

Robert M. Morgan has been appointed field representative for U. S. Gasket Co., plastics division of Garlock Packing Co. He will cover the area under the jurisdiction of the Chicago and St. Louis branches.

Bruce S. Galbraith has been named eastern district sales manager for Borden Co.'s Polyco-Monomer department, and will maintain headquarters in New York City. He formerly served as a regional sales manager for Nuodex Products.

Charles H. Atwood has been elected president of Union Carbide Caribe, Inc., a subsidiary of Union Carbide Corp. Most recently, he served as superintendent of the parent firm's plant in Institute, W. Va. His headquarters will be at the new Petrochemicals plant near Ponce, P. R.

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Assures fastest cures at lower molding temperatures of up to 325°F. Made with single-stage resin, new 480 Black has excellent molded properties with freedom from mold staining . . . ideal pourability, operating ease and economy of use. Flow range hard to soft.

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Norman J. Lewis and **James H. Senger,** project specialists in the development department of Monsanto Chemical Co.'s organic chemicals division, have been made section managers. Dr. Lewis succeeds **L. Edward Klein** as manager of intermediates and exploratory chemicals and Mr. Senger replaces **David T. Mowry** as manager of the fine chemicals section.

D. P. Johnson, D. L. Peters, and R. C. **Wise** have joined the development department of Union Carbide Chemicals Co.

Joseph R. McCleskey has joined the production department of Monsanto Chemical Co.'s plastics division plant, Texas City, Tex. **Thomas R. Ames** and **Roger Tirone** have been named to the research department at the division's main office in Springfield, Mass.

Norman T. Shideler has been elected president of Insul-Matic, Inc., a newly-acquired subsidiary of Pittsburgh Coke & Chemical Co. He will be directly responsible for all coatings research and development, and will act as technical advisor to the vice president of the chemical divisions. **Arthur E. Gray** has been named to succeed Mr. Shideler as general manager of the protective coatings division.

Carl F. Arnold, Joseph E. Milardo, and **Richard Ohlson** have been appointed sales managers of Orangeburg Mfg. Co.'s Central Middle Atlantic, North Central, and Pacific Northwest districts, respectively.

Joseph J. Stanton has been appointed a research chemist in the product development department of Atlas Powder Co.'s chemicals division. He will work with Thermaflow reinforced plastic molding compounds.

OBITUARY

William G. Skutch

William G. Skutch, 66, founder and president of Peerless Molded Plastics, Inc., Toledo, O., died August 13, 1957.

Closely associated with the plastics industry since the early 30's, Mr. Skutch was instrumental in establishing what is now the closure and plastics division of Owens-Illinois Glass Co. Aside from his business activities, he was an active member of SPI, and one of the founders of SPE. He is survived by his wife Doris Skutch, a brother Sidney, and two sons.

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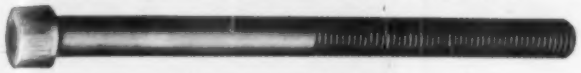

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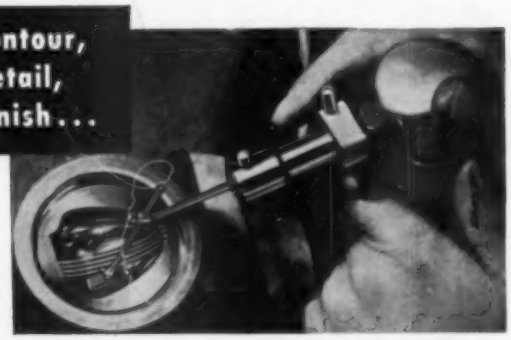

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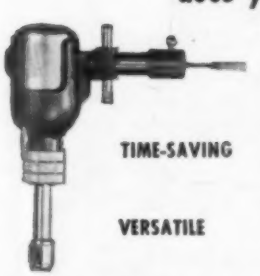

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News from Abroad

Italian Polyethylene Venture

The formation of an Italian company, Celene, S.P.A., has been announced by Union Carbide Corp., joint owner with Societa Edison of Milan, Italy. The new firm will manufacture and market high-pressure polyethylene, and initial plans call for a 24 million-pound production. Union Carbide is well known for its contributions to the plastics field and Edison, the largest Italian producer of electrical power, holds a prominent position in the chemicals, electronic, and metallurgical fields.

Australian Plastics News

The First Australian Plastics Convention, which was held at Canberra on Mrach 24-27, 1957, proved to be a highly successful event. Various government officials and economic experts spoke on the growth and future possibilities of the plastics industry in Australia. It was brought out that in the last 10 years, the number of plastics plants in Australia had grown from 107 to 250. The number of employees had doubled in this period, rising from 3,500 to 7,000. The value of plastics output at present was put at L. 25,000,000.

Recent trade reports reveal a number of new developments, either contemplated or already started. A polyethylene factory is to be built by Imperial Chemical Industries in Sydney this year. This plant will provide employment for some 200 residents, would save Australia about L.1,000,000 in imports, and also be a defense asset. The Australian branch of this firm, I.C.I.A.N.Z., has established a Central Research Center at Ascot Vale, Victoria, in the vicinity of several other I.C.I. plants. The Center is expected to help reduce costs of present products; develop new products and uses, with special Australian needs in view; investigate the possibilities of manufacturing entirely new products; and train new research workers.

Following an agreement with Dow Chemical, C.S.R. Chemicals Pty., Ltd., Sydney, will produce Dow's 475 polystyrene in Australia. Dow is providing full technical know-how for the design, construction, and operation of a new L.500,000 plant under construction at Rhodes, N.S.W. The plant, which is on a site adjoining C.S.R.'s Starex general-purpose polystyrene plant, is expected to begin operating early in 1958. It also has been announced that this company recently began to produce Corflex 880, a new plasticizer for PVC, which is a di-iso-octylphthalate from an eight-carbon alcohol.

On January 31, 1957, an Australian subsidiary of the English firm, Projectile & Engineering Co., Ltd., was formed jointly with Hardie Trading, Ltd., which has been distributing Peco machinery in Australia. The new company, to be known as Peco-Hardie (Pty.), Ltd., will manufacture Peco injection molding machines, extruders, and other equipment, presumably in Melbourne.

Among new plastics products to appear on the Australian market recently are a locally produced polystyrene sheet, and an all-plastic flush tank for toilets. Polystrom Plastics, Ltd., a subsidiary of Hallstrom Pty., Ltd., has begun to produce the polystyrene sheet under the name, Polystrom. Produced on a new six-inch NRM extruder that is said to be the largest of its type in the Southern Hemisphere, the sheet is available in a variety of colors and thicknesses in lengths up to 72 inches and widths of 24, 30, and 40 inches.

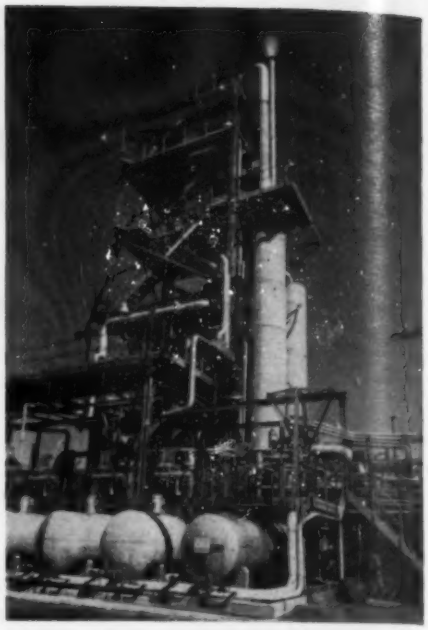
Australian-made Barrene high-impact polystyrene is used in the manufacture of the flush tanks which include a molded lid; a vacuum-formed inner casing with reinforcing ribs; a drape-formed, one-piece outer casing; injection-molded internal components of imported high-impact polystyrene; and a ball float of polyethylene.

Since canvas and rubber shoes designed to protect the feet of sheep from foot rot have not proved successful, plastic shoes are now being tested.

Constructs French Facility

A maleic anhydride facility, built by Scientific Design Co., Inc., New York, N. Y., has been placed on stream by Francaise des Matieres Colorantes (Francolor), Villers-St. Paul, France. Said to be the country's first facility for commercial production of the plastic intermediate, the unit has a rated product delivery in the neighborhood of 2,200,000 pounds per year.

The SD process installed in Francolor's plant represents a radical departure from the current European approach to this type of operation. It incorporates a multitubular catalytic reactor which receives a preheated mixture of vaporized benzene and air. The hot gases leaving the reactor are channeled through a heat recovery unit to a water scrubber where maleic anhydride is absorbed to form maleic acid. This acid solution is dehydrated to regenerate a crude maleic anhydride which is purified in a refining column, pelletized, and packaged.



Francolor's maleic anhydride processing plant.

Metallicized Acetate Film

Rhone-Poulene, Paris, French producers of plastics, has put out a new metallized acetate film produced by a continuous vacuum process. The film has a surface that is smooth and shining enough to reflect objects as does a mirror. This material, named Lumiline, now is being used in France by certain manufacturers to sheathe metal tubes. The resulting product is claimed to be comparable in appearance to the finest gilt or chromed tubing, and is finding application in table legs, towel bars, and display racks. The cost of producing this tubing, which is said to be giving entire satisfaction in use, apparently works out lower than that of tubing finished by electro-forming because of the various economies the use of Lumiline permits.

To Make Polyurethane Foams

The Reid New Zealand Rubber Mills will produce polyurethane foams in Auckland, New Zealand, under license from the German company of Bayer Farbenfabriken, and will market the product under the name of Reidoprene.

Plastics in Poland and Romania

As compared with many other countries, Poland's plastics industry is considered to be backward, a situation the current five-year plan, ending in 1960, is designed to remedy. The plan provides

for greatly increased production of such basic materials for plastics as urea, melamine, formaldehyde, and synthetic alcohols, among others. Hence, Poland's rich coal deposits are to be more thoroughly exploited; new products are to be developed, and the output of others expanded considerably.

Plans to advance the plastics and synthetic rubber industries in Romania also are being pushed. These industries are based on petroleum which is a major resource of Romania, output in 1956 reaching about 11,000,000 tons; in addition, natural gas is plentiful. At present, the plastics industry here produces phenol and urea resins, PVC, polyvinyl acetate emulsions, polyamide injections molding compounds, and relon polyamide fiber. Tests have been conducted in producing both high- and low-pressure polyethylene by the usual methods (as well as by the so-called atmospheric pressure process,) and commercial production of these plastics is to be started, as well as that of polymethacrylate and polystyrene, especially copolymers of polystyrene. Annual output of all plastics is to be raised to 10,000 tons, and of synthetic fibers to 7,000 tons.

Romanian research on high polymers is being conducted at four up-to-date institutes having a combined staff of more than 400 academic and technologically trained workers.

London Radio Show

Exhibits at the 1957 Radio Show held at Earls Court, London, indicated that Britain's radio industry is well on the way to becoming one of the country's biggest plastics consumers. Molded radio cabinets, printed circuits, pick-up arms, electrical components, and PVC "leathercloth" coverings were among the many applications displayed this year.

Printed circuits made of copper-clad, phenolic-base laminates are being used by many companies, and competition is said to be keen among suppliers of these materials. New developments seen for the first time included a special purpose printed circuit made of woven glass fiber impregnated with epoxy or silicone resins; flexible printed circuits made of epoxy-impregnated paper; and still others made of PVC and polyester films.

In the manufacture of large radio cabinets, wooden structures covered with PVC "leathercloth" are replacing the thermosetting materials formerly used. Because of the colorful combinations of patterns and embossing that can be achieved with the PVC fabrics, this trend is expected to gain popularity. "Leathercloths" have been used extensively in low- and medium-priced record players, and have invaded the high priced field as seen in a group of Hi-Fi sets produced by Pye Ltd., Cambridge. The line featured wooden veneered cases, the inside of which was lined with cream-colored, embossed PVC.

Thermoplastic materials are being used extensively in radio cabinet and component moldings. The Transistor Rhapsody portable model displayed by Kolster-Brandes Ltd., Kent, featured a polystyrene cabinet molded in cream, red, or black. While more expensive than many plastic materials, cellulose acetate butyrate was molded into a case for the portable model Vidor Vagabond. Urea and phenolic radio cases also were used extensively.

Cabinet moldings, however, have failed to gain wide acceptance in the television field, and plastics are used primarily in the manufacture of component parts, and decorative escutcheons.

Opens Polystyrene Plant

Southeastern Asia's first polystyrene manufacturing plant started production recently under the auspices of Polychem, Ltd., Bombay, India. The firm produces Styron under a license agreement with Dow Chemical Co., Midland, Mich.

Polychem was formed in 1955 by Dow and an Indian firm, Kilachand Devchand & Co., Ltd. Fifty per cent of the company's common stock is held by the Indian public while the remaining shares are held by the parent organizations.

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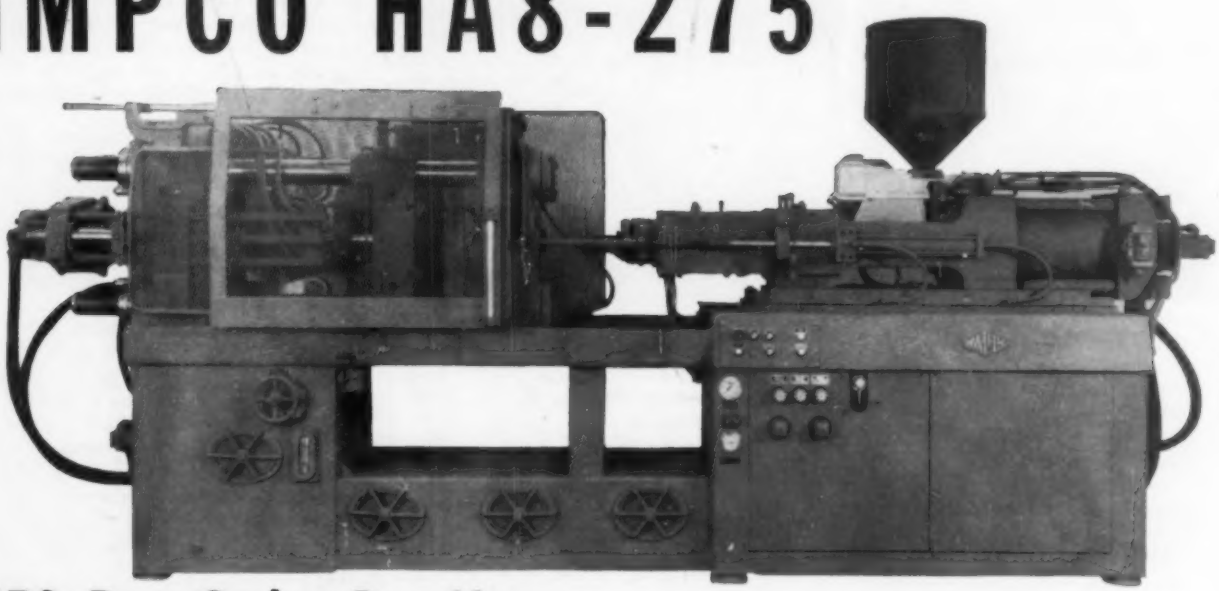

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New Materials

Write item numbers on Readers' Service Card to obtain more information.

Intermediate for Plasticizers

Primary amyl alcohol, a chemical intermediate used in the preparation of ester-type vinyl plasticizers, di-ester-type lubricants, resin catalysts, surfactants, and vinyl stabilizers, is presently available from Union Carbide Chemicals Co. Consisting of approximately 60% pentanol-1, 35% 2-methyl butanol-1, and 5% 3-methyl butanol-1, the material is made by the oxonation of refined butylenes.

Properties are reported as follows:

Specific gravity	0.8134
Boiling point, °C.	133.1
Vapor pressure, mm. Hg.	2.9
Coefficient of expansion per °C.	0.00092
Heat of vaporization at 133° C., Btu./lb.	242
Freezing point, °C.	−90
Solubility in water, % by weight	1.7
Water in amyl alcohol, % by weight	9.2
Viscosity, cps. at 0°C.	8.5
At 20° C.	4.3
At 40° C.	2.4
Refractive index	1.4084
Surface tension, dynes/cm.	24.2

Readers' Service Item M-1

All-PVC Spray Plastisol

A PVC plastisol designed for spraying on cold, vertical metal surfaces to protect them against acids and alkalis at temperatures below 180° F., has been introduced by Quelcor, Inc. Called Quelspray 4282, the material is especially useful for coating all metal articles which are either too large or too small for dipcoating procedures.

Unlike most PVC sprays, which are organosols or modified plastisols containing volatile compounds, Quelspray 4282 is a true plastisol requiring no thinning. It can be left in spray guns overnight, thus eliminating the need for constant cleaning of equipment. No thickness is lost from wet to dry film.

The surface to be coated must be clean, either sandblasted or pickled. Prime by dipping, brushing, or spraying to a 0.2-0.6 mil dry film. Spray equipment should include an air agitator to reduce false body, and the air pressure required is somewhat higher than that needed for conventional sprays. A one-coat thickness of 35-40 mils is recommended, and multiple coats can be applied

The film must be fused in an oven at 365° F., for a time sufficient to allow the entire mass of the plastisol to reach that temperature. In applying multiple coats, the first coat must be cured partially before a second application or, if completely cured, must be wiped with a solvent to assure fusion between coats.

Physical properties are listed below:

Color	Gray-Black
Flammability of cured film	Self-extinguishing
Weight, lbs./gal.	10
Viscosity, cps.	20,000–35,000
Total solids content, %	100
Tensile strength, psi.	2,500–2,700
Elongation, %	290–310
Tear strength, Graves, lbs./in.	200–240
Durometer hardness, Shore A	75
Fadometer, hrs.	500

Readers' Service Item M-2

Glossy-Finish Black Phenolic

A black, general-purpose phenolic molding compound, specially engineered to give a glossy finish, has been introduced by General Electric's chemical materials department. Called G-E 12929, the material is said to offer excellent dimensional stability and withstand temperatures up to 400° F. Early applications include piano keys and camera parts.

Reportedly suitable for cold-powder or pre-heated pill molding, G-E 12929 offers compression molders low shrinkage and minimal thermal expansion. Property data are listed below:

Density, min. gms./cc.	62
Bulk factor of powder	2.36
Flow range	10-13
Impact strength, Izod, ft.lb./in. notch	0.34
Flexural strength, psi.	10,000
Modulus in flexure, psi. x 10^6	1
Tensile strength, psi.	7,000
Compressive strength, psi.	25,000
Specific gravity	1.42
Water absorption, 24 hrs., %	0.45
Shrinkage, mils/in.	6.5
Hardness, Rockwell M	100
Dielectric strength, 60 cycles, 25° C., short time, VPM	300
Power factor, 60 cycles, dry	10
Volume resistivity, ohm-cms. x 10^9	2
Insulation resistance, megohms x 10^4	3

Readers' Service Item M-3

Solid Plasticizer Material

Monsanto Chemical Co.'s organic chemicals division is presently marketing a solid dicyclohexyl phthalate plasticizer with a narrow melting point range of 64-64.6° C. The material is used as a plasticizer for nitrocellulose lacquer coatings on cellophane to improve heat-sealing properties and provide a moisture-proof barrier which resists extraction.

The compound also is used as a primary plasticizer in a variety of resin adhesives and coatings, as a processing aid in rigid PVC formulations, and as a partial replacement of liquid phthalates to reduce oil extraction. Advantages are said to include heat and light stability, extraction resistance, dielectric properties, and compatibility with common resins and solvents. It can be used in combination with other plasticizers in PVC, ethyl cellulose, polystyrene, and methacrylate.

General properties are listed as follows:

Molecular weight	330
Appearance	White solid
Odor	Aromatic
Density	1.29
Vapor pressure at 200° C.	1.1
Flash point, Cleveland open cup, °F.	405
Fire point, Cleveland open cup, °F.	465
Solubility in water, %	0.01
Boiling range, 4 mm. Hg., °C.	220-228
Surface tension, dynes/cm.	36.4
Specific heat, cal./gm.	0.39
Acidity, phthalic acid, %	0.01
Assay, ester content, %	99
Color of melt, APHA	100

Readers' Service Item M-4

Flexible Urethane Compounds

A series of liquid urethane casting resins which cure to form elastomeric products has been introduced by Houghton Laboratories, Inc. Called the Hysol 8530 series, the materials are recommended for encapsulating fragile electronic components, for use as fiber impregnants, and as adhesives and sealants.

Hysol 8530 has terminal groups which react readily with water or water vapor, therefore care should be exercised in its storage. It also contains a certain amount of carbon dioxide, which should be removed by heat and vacuum to insure bubble-free castings. The material is amber in color, and has a viscosity of 23,000-28,000 cps. at 25° C. This viscosity diminishes rapidly with heating, and is but 1,000 cps. at 90° C.

The specific gravity of Hysol 8530 is 1.06, and there is no noticeable odor. The material is self-extinguishing, and can be cured with Hardeners CB, CB-1, CH, or CH-2. Products have excellent low-temperature flexibility at -65° C., coupled with toughness and extreme abrasion resistance.

Readers' Service Item M-5

Plasticizer for Latices

Latex Plasticizer A-12, an anionic emulsion developed as a modifier and extender for curing and non-curing latex systems is presently available from Pennsylvania Industrial Chemical Corp. Compatible with natural, neoprene, styrene-butadiene, styrene-acrylonitrile, and acrylic latices, the material exhibits good softening and plasticizing qualities. It also is said to have good aging characteristics and resistance to water and alkalis.

In addition to its use as a plasticizer, A-12 is recommended for use in the back sizing of decorative fabrics and carpeting, back filling of bagging, adhesives, and laminates. Physical properties are as follows:

Particle size, micron	1
Viscosity, K. U.	55-60
pH	8.5-9.5
Solids content, %	48-51
Mechanical stability, Waring blender, min.	10
Ash content	Trace

Readers' Service Item M-6

Asbestos Reinforcements

Chrysotile asbestos fibers, mined in Venezuela and virtually free of talc, have been introduced by the asbestos division of World Commerce Corp., as reinforcements for polyester molding materials and phenolic laminates. Four grades are available: Amvecos A-1, B-1, C-1, and D-1. They have a specific gravity of approximately 2.44, a pH of 7.4, and a low magnetic-iron content.

Work on asbestos-reinforced phenolic laminates is the more recent, and is reported here. Laminates tested were made from sheets of Amveco Grade B-1 asbestos preloaded with Bakelite 4001, a powdered phenolic resin. Results of tests conducted by Cincinnati Testing Laboratories are reported as follows:

	Dry	Wet—after 24 hrs. H_2O
Flexural strength, psi.	18.000	19.000
Flexural modulus x 10^{-6}	2.09	1.98
Tensile strength, psi.	10.000	9.300
Compressive strength, psi.	15.500	12.500
Impact strength, Izod, ft.lbs./in. notch	1.51	
Heat distortion point, °C.	270	
Water absorption, 24 hrs., %	0.94	

Readers' Service Item M-7

Two-Stage Filled Phenolic

A two-stage, woodflour-filled, general purpose phenolic developed primarily for cold-powder automatic molding has been introduced by Monsanto Chemical Co.'s plastics division. Called Resinox 1007, the material's preheating characteristics allow for substantially-reduced cycle times on automatic presses. It is also suitable for conventional plunger operation, where a medium to medium-stiff flow material is applicable.

Available in both black and brown, Resinox 1007 is said to feature rapid flow, extremely fast cure, and excellent mold and flash release. Physical properties of the material, plus its molded properties, are reported as follows:

Particle size, mesh.	12
Density, gr./cc.	0.53–0.66
Bulk factor	2.09–2.56
Pourability, sec.	12–18
Specific gravity, black	1.36–1.4
Brown	1.4–1.44
Flexural strength, psi.	10.500
Tensile strength, psi.	7.000
Impact strength, ft.lbs./in.	0.32
Compressive strength, psi.	30.000
Heat distortion point, °F.	300
Hardness, Rockwell M.	115
Water absorption, %	0.7
Shrinkage, in./in.	0.007

Readers' Service Item M-8

VANSTAY Z

zinc bearing chelator for PVC resins imparts outstanding clarity, stability and resistance to sulfur staining when used as recommended with other VANSTAYS in many vinyl products.

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New Equipment

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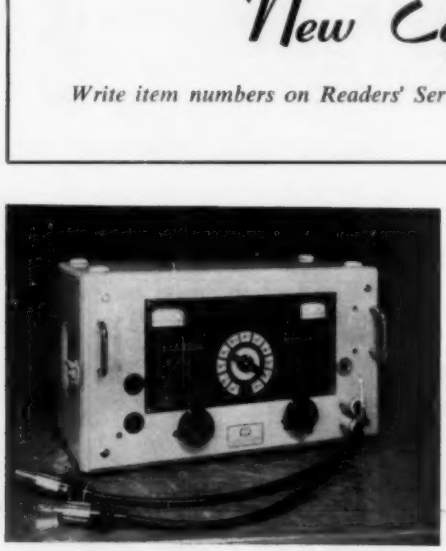


Type FT-VKB Dielectric Test Bridge.

Dielectric Property Tester

A dielectric test bridge designed specifically to measure the electrical properties of dielectric materials has been developed by Federal Telephone & Radio Co. Known as the Type FT-VKB Dielectric Test Bridge, the unit can measure dielectric constant and dissipation factor of materials in either sheet or liquid form provided appropriate accessories are used.

At power frequencies, the dissipation-factor range can be extended to unity through the use of a BN 35209 small-range extension adapter. Capacitors and similar components can be checked as easily as materials. The bridge uses the standard Schering bridge circuit, with adaptations to permit satisfactory operation over a wide frequency range. A balanced transformer is provided at the input terminals to permit operation with an oscillator or signal generator having either coaxial or balanced output.

Connection to the test material is through a three-terminal network, with the two test terminals above ground. This eliminates difficulties when using shields and guard circuits. The bridge balancing procedure is direct and simple, requiring adjustment of only two controls. Results are read on two scales with anti-parallax cross-hairs. The capacitance is read directly, and the dissipation factor is equal to the dial readings times the measuring frequency.

Specifications are reported as follows:

Accuracy, %	1
Dissipation factor range	10^{-4} to 10^{-1}
With range extension adapter, %	1
Frequency range, cps.-kc.	50-300
Input voltage	10-40

Readers' Service Item E-1

Horizontal Laboratory Mixer

A compact, horizontal mixer featuring a cross-blending action has been introduced by Rapids Machinery Co. Called the Marion Laboratory Mixer, the unit's inside dimensions are as follows: 24 inches long, 12 inches wide, and 16 inches deep. Capacity is two cubic feet, or approximately 50 pounds.

The mixer is available in either mild or stainless steel, and is equipped with a ¾-hp. gearhead motor. Angle iron legs and a sponge rubber-gasketed metal cover are included. The lab mixer, which can be used as a production unit, is the newest addition to Rapid's line of Marion mixing equipment.

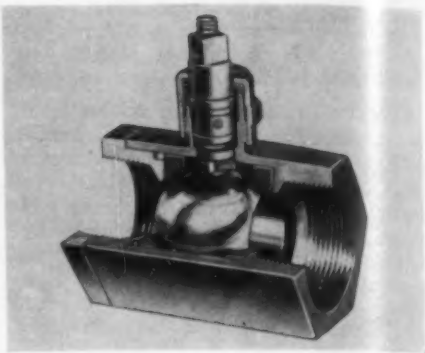
Marion horizontal laboratory mixer.

Readers' Service Item E-2

High-Vacuum Ball Valves

A line of high-vacuum ball valves in bronze, aluminum, mild steel, 303 or 316 stainless steel, and PVC has been introduced by NRC Equipment Corp. They are available in sizes from ¼-6 inches, operated manually or by air motor. All valves are tested for vacuum tightness on a helium-sensitive spectrometer.

Advantages in high-vacuum service are reported as being flexibility, simplicity, and low cost. They hold vacuums in either direction, and their lightness allows mounting in any position. A quarter turn of the stem provides rapid opening and closing, and also permits precise throttling. In full-open position, they are circular in cross section and approximate the size of connecting pipes.



NCR's vacuum ball valve seen in section.

A minimum of internal surface virtually eliminates outgassing. Dirt in the system can be tolerated, due to the wiping action of the seals on the ball surface.

Readers' Service Item E-3

Portable Pipe-Wall Gage

A portable unit which permits the rapid, non-destructive measurement of pipe-wall thicknesses has been introduced by Industrial Nucleonics Corp. Known as the AccuRay Portable Pipewall Thickness Gage, the completely transistorized unit accommodates pipe ranging from 2-8 inches nominal in diameter. It weighs but 7½ pounds.

The measurement part gives a reading independent of pipe diameter, maintaining a permanent calibration. Since the principle of radiation absorption is used, plastic and other nonferrous piping can be measured. Reproducibility and resolution of better than ±10 mils are achieved throughout the range of 0-1 inch thick pipe walls. This range covers pipe up to Schedule 160.

To read, the inspector places the detector in position on the pipe, presses the measuring button, and notes the reading on the meter. An integrating circuit eliminates the need for averaging and interpreting fluctuations of the needle.

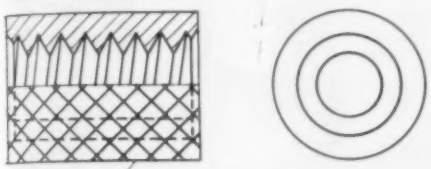
Pipe-wall thickness gage, case, and strap.

Readers' Service Item E-4

Tru-Threaded Aluminum Insert

A line of through-threaded aluminum inserts for plastics, rubber, and ceramics has been introduced by Yardley Precision Products Co. Called the Yardley Type B Inserts, they are marketed in plain, brass-plated, and clear anodized aluminum. A coarse outside knurl is provided for maximum holding power.

Holes are tapped with Class II threads to conform to ASME specifications in thread sizes from 4-40 to ¼-28. They are reamed to close tolerances after tapping to facilitate the inserts' placement on the die's locating pins.



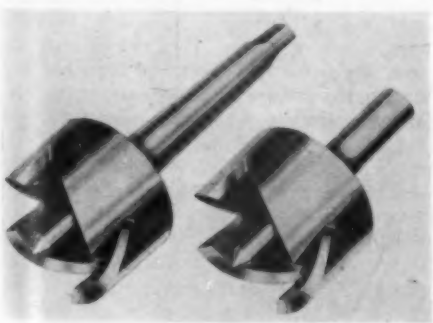
Yardley aluminum inserts.

Readers' Service Item E-5

Concentric Rotary Bore Tool

A new rotary boring tool which is said to produce perfectly concentric, practically burr-less holes in sheet and plate materials has been introduced by Jancy Engineering Co. Called the Roto-Bor, the tool has four cutting lips instead of the conventional two, and can be used with materials up to ¼-inch thick.

Available in 1/16-, 1/32-, and 1/64-inch sizes from 13/16-2 1/32 inches, the Roto-Bor is engineered specifically for hole cutting in the thicker and tougher materials. Sizes from 1-1 1/32 inch are supplied with No. 2 Morse taper shanks, and sizes from 1 5/16-2 1/32 inch are provided with a No. 3 Morse taper shank. The above sizes are available also with ½-inch straight shanks.



Jancy's Rotor-Bor cutting tools.

Readers' Service Item E-6

MIN CHEMISTRY *at work*

case:

Big, strong, dense, translucent reinforced plastic part at high filler loading

This is a fiberglas fertilizer hopper for farm field rigs. It's about 17" in height and diameter. Goodyear Aircraft Corp. mass-produces it by the preform-liquid mold method.

MINERAL FILLER REPORT: ASP 400 is the M & C filler used in this hopper. Goodyear says ASP 400's performance in all five critical "areas" is unmatched by any other filler:

a. *Smooth, dense, strong part*—to end trouble from acids, weather, breakage.

b. *Translucency* to see contents at a glance—due to ASP 400's excellent wet-out and suspension.

c. *No reaction on resin*—no catalytic effects . . . long pot life.

d. *High filler loading*—no viscosity problems.

e. *Molding ease, proper flow* and *thixotropy*—giving fast die fill-out and closing for high production, low reject.

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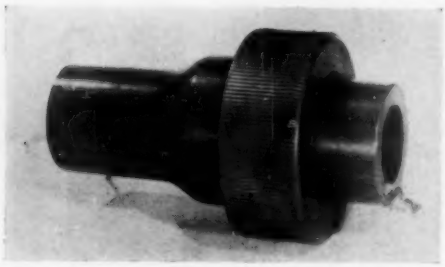


Tube Turns' PVC lift check valve.

All-PVC Lift Check Valve

Tube Turns Plastics, Inc., at the request of piping engineers in the chemical and petroleum fields, has developed an all-PVC lift check valve which will operate in either a vertical or horizontal position. Less than six pounds of pressure are required to open and close the valve, which has a full 100% flow area.

The valve's only moving part is a self-energizing disk. A one-inch prototype has been in operation at Tennessee Gas Transmission Co.'s refrigerated extraction plant in Greensburg, Ky., since January 3, 1957. It has opened and closed 37,905 times per day, on the average, with no signs of wear. The line carries a 10-15% sulfuric acid solution which bears traces of sand in suspension, and serves a 72-stroke per minute pump. There is a six-foot discharge head and a 8-20 inch suction lift.

Brass valves used in this type application had a life span of six months. Stainless steel performed satisfactorily over a much longer period, but represented a considerable investment. The PVC valve is available in ½-, ¾-, one-, 1¼-, 1½-, two-, and three-inch sizes, and in threaded or socket welding types.

Readers' Service Item P-1

Nylon-Reinforced Glazing

Shatter-proof glazing panes for factory windows are now supplied precut to all standard sash sizes by Filon Plastics Corp. Made from Fiberglas- and nylon-reinforced polyesters, the panes are packaged in cartons of 50. No special maintenance is required.

Six, light-engineered colors which allow pre-selection of degrees of daylight are presently available. The panes are reportedly more resistant to cracking and chipping than panels which are reinforced with glass fibers alone.

Readers' Service Item P-2

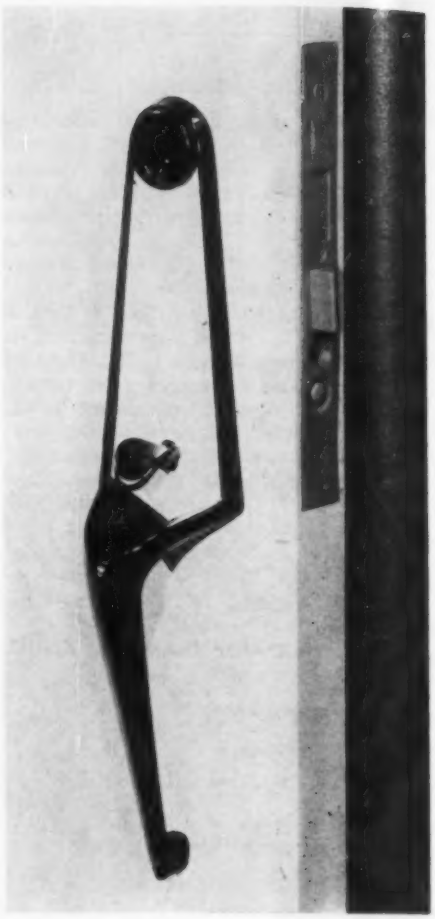
Interlocking Styrene Panels

Interlocking multi-colored wall panels of Catalin high-impact polystyrene are available from Cermak Tile Co., Inc. Called Strypanel, the striated panels are extruded in one- by eight-foot and one-by 4½-foot sections, and are guaranteed against chipping, buckling, cracking, and crazing.

The panels feature random striping in twelve color combinations. Matching corner and mold trims are available in plain compatible colors. Reportedly no more expensive than ordinary plastic wall tile, Strypanels have Panel-lok, an exclusive locking arrangement which operates similar to the tongue-and-groove construction found in expensive wood paneling. On installation, the panels give the effect of a continuous, seamless application.

Interlocking styrene wall panels.

Readers' Service Item P-3



Molded nylon door handle and lock.

Colored Nylon Hardware

Black hardware for exterior doors are being molded from Zytel, DuPont's nylon resin, by the company's sales service laboratory. Still in the test-model stage, the mortise-type door lock set is combined with a cylinder and nylon plug manufactured by the Taylor Lock Co.

Black was chosen for its ability to blend in or contrast with colored exterior doors. Latch bolts, base plate, striker plate, latch buttons, and screws are tan. The interior door knob and latch-operating components are chocolate brown.

It is felt that the nylon door latches have a bright future, since they can be mass-produced in a variety of intricate shapes. Colors will not chip, fade, or dull, and the hardware is resistant to heat, cold, and abrasion. The nylon plug resists the wearing action of repeated key usage; thus, tumbler holes maintain their original line-up with the plug face and maximum lock security is retained. Self-lubricating, the nylon pin tumblers ride smoothly in the tumbler holes and the plug turns easily in the cylinder.

Nylon's light weight is an important factor for hardware manufacturers to consider, since it means more parts per pound, lower shipping costs, and simplified packaging.

Readers' Service Item P-4

Polyethylene Film Meat Bag

A new use for polyethylene film has been found by Central Provision Co., which now ships about 20 carloads of meat each week in polyethylene bags to hold shrinkage to a minimum. Existing procedure calls for a 100-150 pound drop in payable received weight on a shipment of 20,000-30,000 pounds, and excessive shrinkages due to fluid loss are passed on to the general consumer.

Using 1.5-mil Bakelite polyethylene film, the polyethylene bag division of Equitable Paper Bag Co., supplies Century with bags which are air-tight and hold shrinkage to a minimum. In addition, the bags will not absorb fluids, nor will they crack open in freezing temperatures.

Meat shippers now use polyethylene film to prevent shrinkage in transit.

Readers' Service Item P-5

Nylon Hose Couplings

Nylon hose couplings, molded from Du Pont's Zytel resin, have been introduced by Stile-Craft Mfg. Co. Called Quik-Connect, the coupler easily survives and is resistant to changes in water temperature, garden sprays, insecticides, detergents; and clean-

Nylon coupling for garden hose.

RC plasticizer DIDP-10

for wire coating applications!

TYPICAL ELECTRICAL CHARACTERISTICS		
Dielectric constant (ASTM D150-47T)	@ 60 cycles	4.34
	@ 1000 cycles	4.33
Power factor (ASTM D150-47T)	@ 60 cycles	0.65%
	@ 1000 cycles	0.05%
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A modified di-iso-decyl phthalate with superior electrical properties plus low temperature flex in poly-vinyl chloride compounds.

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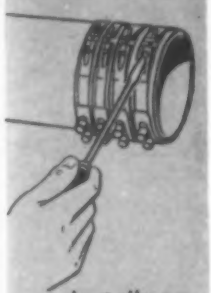

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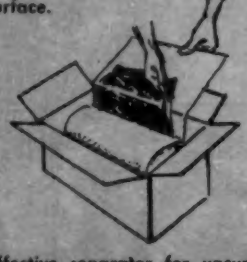
Patapar is the ideal protective backing for pressure sensitive plastics — can be attractively printed for product identification.

In the manufacture of polyester Fiberglas sheets, Patapar provides an efficient release backing. Imparts satin-like finish.

Patapar performs perfectly as a separator for rubber tape. Also used as a core cover.

Ideal as a protective release backing for pressure sensitive surfaces. Fiber-free, Patapar will not form a fuzz on the protected surface.



Effective separator for uncured, natural or synthetic rubbers. Imparts a smooth surface. Resists adhesion build up.

Patapar Releasing Parchments have dense, fiber-free texture — high resistance to penetration or migration of oil and softeners — permanent releasing action. They are totally inert to any surfaces they contact.

They show excellent performance in many processes involving: *synthetic rubbers, polyurethane foams, polyesters, vinyls, organic adhesives, organosols, phenolics, acrylics.*

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ing solutions.

Both the male and female halves of the coupler are fitted easily to the metal threads. Simply push to connect; twist to disconnect. The coupler not only saves the time usually required to "break" threaded connections, but affords an improved, leak-proof seal. Any number of attachments such as sprinklers, nozzles, brushes, and the like can be interchanged within seconds.

Readers' Service Item P-6

Improved Polyethylene Nurser

Four firms cooperated to produce a plastic nursing bottle which will withstand repeated sterilizations in hospital autoclaves, where temperatures are maintained at 250° F. Called the Feed-Rite Nurser, it consists of a high-density polyethylene bottle, silicone-rubber nipple, and snap-in seals and nipple covers of the same high-density polyethylene.

The nurser is marketed by Davol Rubber Co., manufacturer of glass nursing bottles and special rubber nipples. Plax Corp. blow-molded the bottle from Marlex 50, Phillips Chemical Co.'s low-pressure polyethylene which has a density in the range of 0.95-0.96. The nipple covers and collars were produced by Cowan Boyden Corp., using multiple cavity molds.

Marlex's greater rigidity permits the use of a lower gage, thus offsetting the higher price-per-pound over conventional polyethylenes. It also gives a lighter product. The eight-ounce Davol nurser weighs 25 grams as compared with 40 grams for a conventional polyethylene bottle, or the 200-gram glass type.

High-density polyethylene nurser withstands exposure to live steam. Conventional polyethylene bottle (right) collapses.

Readers' Service Item P-7

New Literature

Write item numbers on Readers' Service card to obtain copies.

"Research Laboratory Digest." No. 1. General Electric Co. 41 pages. This periodically-published digest reviews the activities of the company's research laboratories. Of interest, is a history of the laboratory's work in electron chemistry which discusses the use of electron irradiation to produce polymerization, depolymerization, and cross-linking of solid polymers.

Readers' Service Item L-1

"A New Answer To An Old Problem." Bakelite Co. 8 pages. This illustrated brochure describes in detail the advantages of vinyl plastics in silo construction.

Readers' Service Item L-2

"Gradation Tropiglas." Russell Reinforced Plastics Corp. 2 pages. Available colors and suggested applications of a glazing material are listed in this leaflet. An average light-transmission curve for the different types is included.

Readers' Service Item L-3

"Synthetic Waxes." Glyco Products Co., Inc. 16 pages. Physical properties, compatibilities, and suggested uses for nine waxes are given in this booklet.

Readers' Service Item L-4

"Pangborn Rotoblast Deflashing Machines." Bulletin No. 228. 6 pages. Specifications and application data are included for both the Blastmaster barrel for mass production cleaning and the Rotoblast table for quick deflashing of fragile parts.

Readers' Service Item L-5

"Byers PVC Pipe." A. M. Byers Co. 30 pages. This catalog lists data on the firm's new line of PVC pipe, including its properties, applications, and installation. An eight-page chart classifies the corrosion-resistance ratings of Types I & II PVC, plus other types of piping.

Readers' Service Item L-6

"Physical Properties of Curifoam—Part I, Mechanical Properties." Joseph Marin, Joseph Schwaighofer, and P. G. Bhuta for Curtiss-Wright Corp. 40 pages. Compiled by the above listed men, who are connected with the departments of engineering mechanics and engineering research at Pennsylvania State University, the work includes many tabulations and graphs. Among the mechanical properties investigated and tested were stress-strain in tension, tension set, compression-deflection properties, compression set, compression indentation resistance, stress-strain properties in shear, flexure set, and abrasion resistance.

Readers' Service Item L-7

"Specifications and Characteristics of Organic Chemicals." Emery Industries, Inc. 4 pages. As the title implied, information is given on Emery special acids, Emolein lubricant esters, oleic esters, Plastolein plasticizers, and fatty acid products.

Readers' Service Item L-8

"Cementable Teflon and Adhesives for Teflon." Technical Bulletin A-3D. Chicago Gasket Co. 1 page. This bulletin lists sizes, thicknesses, and prices for cementable Teflon tapes and sheeting, along with prices and sizes of a special contact adhesive.

Readers' Service Item L-9

"New Tools for the Plastics Industry." Electromold Corp. 4 pages. This brochure explains how Nicoform electroformed cavities are made, and suggests new design possibilities for phenolic, impression-molded closures. It suggests such applications as impossible hobbing jobs, those with close tolerances, or those with very deep cavities. Ways by which electroforming can be used in repairing crushed lands, restoring corners, etc., also are covered.

Readers' Service Item L-10

"Plastic Plugs, Caps, and Protectors." Bulletin P 5708. S. S. White Plastics Division. 18 pages. Over 200 different plastic protectors are discussed in the bulletin, including the rigid acetate quality line, and the flexible vinylite economy line. Major plug and cap designs are described, and their key specifications are tabulated. Over 100 photos and drawings are included.

Readers' Service Item L-11

Protection against loss of color, loss of tensile strength and embrittlement are vital to your successful marketing of vinyl products. You know this!

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Book Reviews

"Evaluation of Low-Dielectric Glass Fabric." F. Werren and B. G. Heebink, Forest Products Laboratory, for Wright Air Development Center. Order PB 121859 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 24 pages. Price, 75¢.

A new glass composition called 6-6-4 was found to have better electrical properties than the standard "E" glass when used in glass-fabric-base plastic laminates. Strength and elastic properties were lower, however.

"Fundamental Studies on the Adhesion of Organic Materials to Metal Substrates." R. L. Patrick and W. A. Vaughan, Quantum, Inc., for Wright Air Development Center, U. S. Air Force. Order PB 121982 from OTS. U. S. Department of Commerce, Washington 25, D. C. Paper, 121 pages. Price, $3.25.

Little is known about the actual bonding forces operating across an interface. The researchers feel that, if proper join conditions could be realized, any organic material is inherently a good adhesive. Model systems were prepared by depositing monolayers on substrates with weight added as bulk polymer polymerized directly on the monolayer. The samples were then ruptured. By proper selection of substrates, it was possible to examine the monolayer with an ellipsometer prior to rupture testing. Following rupture testing, the monolayer was examined again to determine whether or not the monolayer in the interface was removed from the metal substrate. In no case was it removed.

"Enciclopedia Annuario della Materie Plastiche." Edited by Revista Materie Plastiche, published by L'Industria; both of Via Farnetti 8, Milan, Italy. Vinyl, 8½ by 12 inches, 1042 pages. Price, 1,000 Lire, plus postage and wrapping.

Beautifully bound in a silky PVC cloth over moltoprene, this encyclopedia of the Italian plastics industry was prepared by the editors of "Materie Plastiche" magazine, in collaboration with 81 experts in the field. First publication of its kind in Italy, it features both thoroughness of coverage and beauty of layout. Many illustrations are in color.

There are two main sections to the volume: encyclopedia and yearbook. The former deals with synthetic resins and adjuvants in 36 chapters; an entire chapter being devoted to the newly-developed polypropylene. These chapters cover the history of the product, its chemical composition, properties, applications, and bibliographies. Eight chapters are given to machinery and equipment, 13 to processing techniques, and 18 to applications.

The yearbook contains several directories of the Italian plastics industry: a general directory; a classified list of manufacturers, distributors, and importers; and a listing of molders, converters, and manufacturers of equipment. Finally, there is an alphabetical list of over 6,000 trade names of Italian, European, and American materials and firms.

"Elevated Temperature Resistant Silicone Structural Adhesives for Metals." F. J. Riehl, Jr., and M. B. Smith, Narmco, Inc., for Wright Air Development Center, U. S. Air Force. Order PB 131024 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 41 pages. Price, $1.25.

Two methods of synthesizing a silicon-containing polymer suitable for a high-temperature adhesive were investigated. Polymers made from polyhydroxy compounds and halosilanes proved too susceptible to hydrolysis; however, polysiloxane and polysilane resins containing tolyl groups proved to be better high temperature-resistant laminating resins than metal-to-metal adhesives. The tolyl groups oxidize to form polar carboxyphenyl groups.

"Effects of Rubber Compositions, Rubber Chemicals, and Plasticizers upon Polyethylene." S. Axelrod, Picatinny Arsenal. Order PB 131091 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 19 pages. Price, 50¢.

Rubber compositions generally do not affect seriously the tensile strength and elongation of polyethylene. An exception to this statement would be rubber formulations containing hydrocarbon or ester plasticizers which bleed to the surface. The report shows that at 77° C., either a coal-tar distillate or stearic acid causes polyethylene to disintegrate. Ester plasticizers cause the plastic to lose 1-27% of its strength.

"The Oxidative Degradation of Polyethylene." H. C. Beachell and S. P. Nemphos, University of Delaware for Wright Air Development Center, U. S. Air Force. Order PB 121682 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 24 pages. Price, 75¢.

The relatively simple structure of polyethylene, plus its industrial importance, have stimulated numerous studies on the degradation mechanism of the elastomer, both in the presence and absence of oxygen. This work reports degradation studies on the polymer in molecular oxygen at 150-250° C., in ozone-enriched oxygen between 20-109° C., and in fuming nitric acid at 25-83° C.

Solid, liquid, and vapor products were analyzed through their infrared spectra. The kinetics of oxidation were determined by measurements of oxygen absorption at both constant pressure and constant volume, and by the spectroscopic increase in carbonyl-band absorption. The absorption of oxygen appeared to be second order with an activation energy of 8-9 kcal/mole for the volumetric and manometric studies as well as for the ozone-catalyzed reaction.

The Elevich equation for chemisorption was applied successfully to the kinetic data. The reaction appeared to be a typical free-radical one with a hydroperoxide intermediate. Oxidation with ozone was comparable to that with oxygen, and ozone affected only the initiation reaction. Oxidation with nitric acid, with an activation energy of 35.6 kcal/mole, proceeded by a different mechanism.

"Stress Relaxation and Dynamic Properties of Ethylene Polymers." E. T. Oskin and B. Maxwell, Princeton University for U. S. Army. Order PB 121924 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 39 pages. Price, $1.00.

The physical properties of a linear polyethylene are compared with those of a regular grade polyethylene, using standard and stress-relaxation tests. In addition, a dynamic mechanical test was applied, which enabled interrelation of most engineering properties. It was shown that the physical properties of the linear material as well as the branched, regular polymer are highly dependent upon stress, time, and temperature under normal usage. Using only one small sample, the nondestructive dynamic mechanical test indicated the behavior of the material over a wide range of conditions.

"Investigation of the Vacuum-Forming Process for Plastics Fabrication." H. Gross and W. L. Price, Army Chemical Center. Order PB 121954 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 14 pages. Price, 50¢.

The Army Chemical Corps considers vacuum forming to be an efficient, cost-cutting method for producing thermoplastic items and components for the evaluation of prototype designs. The cost of mold modifications to improve design is low, lead time is short, and the process eases the task of tooling up for greater production once a design has been accepted.

Abstracts of Important Articles

Materials

"Dermatoses and Epoxy Resins," E. N. Dorman, *SPE J.*, 13, 8, 25 (Aug. 1957).

A brief review of the toxicological effects of epoxy resins, based on the work of E. Grandjean, of the Swiss Federal Institute of Technology, and the preventive measures to be used in plants to prevent severe skin disorders and lost working time.

"Flow Behavior and Turbulene in Polyethylene," R. F. Westover and Bryce Maxwell *SPE J.*, 13, 8, 27 (Aug. 1957).

Results are given of a study of the effects of temperature, pressure, and tube diameter on the rate of flow of polyethylene, and their relationships to the effective viscosity of the extruded material. The relationship of the rate of flow to the final diameter of the cooled polyethylene cylinder was studied for all temperatures and tube sizes used. An attempt was made to obtain a better understanding of the phenomenon of turbulene in plastic materials.

"New Epoxy Resins for Reinforced Plastics," E. W. Krummel, P. A. Thomas, and J. L. Welch, *Western Plastics*, 4, 8, 18 (Aug. 1957).

Information is given on wet and dry-up laminates based on one of the new epoxies prepared by peracetic acid epoxidation of a higher olefin.

"Shape Extrusion Studies on Nylon Resin," K. G. Toll, *SPE J.*, 13, 7, 17 (July 1957).

This SPE Conference paper discusses the adaptability of high-melt viscosity Zytel nylon resins to existing extrusion practice, with special emphasis to take-off, vertical and horizontal water-quench techniques, air gap control, and post-handling details.

"Styrene Monomers: Safety in Handling and Storage," R. F. Helmreich, *SPE J.*, 13, 7, 22 (July 1957).

The fire hazards involved in handling styrene are the same as for any flammable organic liquid. Simple precautions permit safe handling and use of styrene monomers.

"Methylstyrene Molding Compounds," J. A. Melchore, *SPE J.*, 13, 7, 33 (July 1957).

An SPE Conference paper that gives a review of the preparation of methylstyrene, the manufacture of methylstyrene-acrylonitrile copolymer, and the moldability, low-temperature impact strength, cold flow properties, coloring, and applications of methylstyrene.

"Binders for Glass Preforms," G. W. Burton, *SPE J.*, 13, 7, 30 (July 1957).

An analysis of the various types of binders in use currently, the reasons for such use, and the particular areas in which each type can be used to maximum advantage.

Equipment

"Molds and Injection Molding of Large Objects of Polyethylene," M. Sirtoli, *Materie Plastiche*, 23, 3, 179 (March 1957).

Molds for injection molding of tubs with handles, covered pails, funnels, and basins in polyethylene are described. (In Italian.)

"Examples of Rationalization in High Frequency Welding," G. Hartung, *Plaste u. Kautschuk*, 4, 2, 63 (Feb. 1957).

Equipment is described to illustrate how efficiency and economy in serious welding can be increased with the aid of accessory tools created by very simple means. (In German.)

"Ultrasonic Machinery," R. V. G. Elwes, *Plastics (London)*, 22, 236, 179 (May 1957).

Ultrasonic methods for the manufacture of molds for the plastics industry are described as applied to the production of a mold assembly for electrical connectors. It appears that use of ultrasonic machinery will be limited to small mold manufacture, but quite complicated shapes are possible. In certain circumstances, machining times and, hence, tooling costs also can be reduced.

"Fundamentals of Kneading, Dispersion and Plasticizing Processes," J. Aeschbach, *Kunststoffe*, 47, 5, 247 (May 1957).

The principles of mixing and kneading, as observed in practice, are reviewed briefly. The machines used in these processes are discussed on the basis of some typical applications. (In German.)

Processing

"Embedding — Combining — Gluing: Three Important Aids for Obtaining Satisfactory Plastic Structures," H. Bischoff, *Plaste u. Kautschuk*, 4, 1, 31 and 4, 2, 66 (Jan. & Feb. 1957).

Discussion of the right way to utilize embedding, combining, and gluing processes to produce components of plastic-to-plastic, plastic-to-metal, and bonds to other materials when both the properties of the plastic and the purposes of the final object are taken into account. (In German.)

"Uniform Plastic Stock Temperature Means Better Injection Molding," A. L. Bird and J. Eveland, *SPE J.*, 13, 10, 41 (Oct. 1957).

How heating molten plastic uniformly throughout can aid in preventing silver streaking, discoloration, brittleness, sink marks, and crazing of moldings. Improved cylinder designs can help in trouble-free molding.

"Pattern-making in Plastics," H. G. King, *Plastics, (London)*, 22, 236, 181 (May 1957).

The materials and equipment required for making patterns employing epoxy resins are described. The preparation of the master pattern and plaster molds, the procedure for pouring and completion of the cast, its reinforcement, and the maintenance and mounting of patterns, all are described.

"High-Frequency Welding of PVC Film," H. Klinzner, *Kunststoff-Rundschau*, 4, 4, 147 (April 1957).

Some of the problems involved in high-frequency welding of PVC foils are discussed. New developments in the design of some German equipment and generators are described. (In German.)

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

Request for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines is printed here quarterly.

The next complete listing will appear in December.

Applications

"Cellular Vinyl Foams," W. G. McLain, *SPE J.*, 13, 7, 41 (July 1957).

Diversified uses and a bright future are seen for vinyl foams. Factors discussed include blowing agents, sponge thickness, blowing methods, uses in furniture and insulation, and relative costs.

"Industrial Molded Packaging Materials, Tooling and Machines," Bennett Nathanson, 13, 7, 38 (July 1957).

Problems in rigid package manufacture discussed in this SPE Conference paper include those of mold filling, runner systems, plasticizing cylinder, hot-runner molds, container parts and lids, materials, fast fill rates, and mold core shift.

"Plastics for Packaging Foodstuffs—A Study of Solubility Characteristics of Plastic Products as Carried Out on an American Polyvinylidene Chloride Film," L. Robinson-Gornhardt, *Kunstoffe*, 47, 5, 265 (May 1957).

This investigation is aimed chiefly at giving a general view of the solubility characteristics of plastics and the possibility of interaction between container and contents. (In German).

"Plastic Tooling Uses of Polysulfide-Epoxy Resins," E. H. Sorg and A. J. Breslau, *SPE J.*, 13, 6, 115 (June 1957).

An SPE Conference in which polysulfide liquid polymer-flexibilized epoxy resin is shown to possess a combination of properties required for cast structures in plastic tooling.

General

"Case-Hardening of Compression and Injection Molds for Plastics," W. Haufe, *Plastverarbeiter*, 8, 1, 2 (Jan. 1957).

Case hardening steels most nearly answer the extremely varied requirements of a good material for compression and injection molds. The principles of case-hardening and nitrating, as well as the main sources of defects and ways of avoiding them, are explained. (In German).

"Possibilities of Automation in the Plastics Industry," Anonymous, *Kunstoffe*, 47, 4, 164 (April 1957).

The problems and necessary conditions for adapting automation to the chemical industry are treated on the basis of information obtained in a recent visit to Chemische Werke Huls, A. G. Installations are described where automation already has been introduced to produce acetylene, ethylene, acrylonitrile, and PVC suspensions. (In German).

"Protecting Floor Coverings," Ch. Saint-Mleux, *Ind. Plastiques Mod.*, 9, 4, 13 (April 1957).

Manufacturers of protective coatings for floor coverings must adopt adequate measures to insure compatibility of coating and flooring in order to provide suitable guarantees to the purchaser. (In French).

"Reinforced Laminates for High Temperature Use," S. G. Salzinger, *SPE J.*, 13, 8, 42 (Aug. 1957).

Plastics suitable for high-temperature use include phenolics, silicones, and epoxies. Best results require judicious selection of resin and filler, and special attention to the methods of curing.

"Danger in the Reinforced Plastics Industry," R. C. Berg, *SPE J.*, 13, 6, 35 (June 1957).

A discussion of the health hazards involved in reinforced plastics processing.

"Patents, Trademarks and Copyrights," C. F. Kiech, *SPE J.*, 13, 8, 37 (Aug. 1957).

Fundamental principles for the plastics engineer are explained.

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Patent Digest

Materials

Preparation of Polymerization Initiators. No. 2,786,036. Louis R. Freimiller, Philadelphia, and Charles H. McKeever, Meadowbrook, Pa. (to Rohm & Haas Co., Philadelphia, Pa.)

Aluminum chloride is mixed with lead tetraethyl under anhydrous conditions and heated to about 80-90° C., to complete the reaction. Any remaining lead tetraethyl is decomposed by further heating to 145-170° C., and the reaction product is distilled off to form an activated aluminum polymerization catalyst for olefins.

Plasticized Acrylonitrile Compositions. No. 2,786,043. Walter H. Schuller, Stamford, and Edward J. Kerle, South Norwalk, Conn. (to American Cyanamid Co., New York, N. Y.)

A composition comprising a polymerization product containing at least 75% by weight of acrylonitrile, and a plasticizer consisting of a polymer of N-vinyl-2-oxazolidone.

Pigmented Vinylidene Plastics and Method for Preparing the Same. No. 2,768,822. Vincent C. Vesce, Smoke Rise, Kinnelon, N. J. (to B. F. Goodrich Co., New York, N. Y.)

Pigment is dispersed in a vinylidene resin by milling the two materials in a liquid grinding medium comprising water and a solvent. The grinding medium is present in sufficient quantity to give fluidity to the mixture, without causing substantial agglomeration or solvent action. When the dispersion is complete, the solids are separated from the liquid portion of the milled mixture.

Heat Shrinkable Filmand Process for Producing the Same. No. 2,784,456. Thomas Aloysius Grabenstein, Buffalo, N. Y. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

An amorphous polyethylene terephthalate film is subjected to an inert gaseous atmosphere and maintained at a temperature from 110°-150° C., after which it is stretched in a transverse direction and allowed to cool while under tension. This prevents possible shrinkage.

Heat-Stabilized Polychlorotrifluoroethylene Utilizing Metal Nitrites. No. 2,784,170. Andrew T. Walter, South Charleston, and Donald M. Young, Charleston, W. Va. (to Union Carbide Corp., New York, N. Y.).

A polychlorotrifluoroethylene resin stabilized against color development and degradation of melt-viscosity at molding temperatures by the presence of about 0.01 to 2.5 parts by weight of a metal nitrite per 100 parts of resin.

Purification of Acrylonitrile. No. 2,784,217. Robert L. Maute, Texas City, Tex. (to Monsanto Chemical Co., St. Louis, Mo.).

Acrylonitrile is purified by treatment with a minor amount of a compound chosen from the group consisting of phenylhydrazine and 2,4-dinitrophenylhydrazine in the presence of a mineral acid in an amount sufficient to maintain the reaction mixture at a pH of less than 7.

Liquid Compositions Comprising a Nitrogenous Polymer. No. 2,784,166. Henry P. Wohnsiedler, Darien, Conn., and Edward L. Kropa, Columbus, O. (to American Cyanamid Co., New York, N. Y.).

A liquid composition comprising by weight, a major proportion of water, and a minor proportion of a polymer obtained by maintaining a polyethylne melamine in contact with acidic water until it has polymerized to the desired degree.

Cadmium Alkyl Vinyl Phosphonate Stabilized Halogen-Containing Resin Compositions. No. 2,784,171. David H. Chadwick, Webster Groves, Mo. (to Monsanto Chemical Co., St. Louis, Mo.).

A composition resistant to the discoloring effects of light comprising a halogen-containing resin and a cadmium alkyl vinylphosphonate whose alkyl substituent contains from 1-6 carbon atoms.

Treatment of Polyethylene Terephthalate. No. 2,785,085. Kenneth L. Sayre, Lorain, O. (to Bjorksten Research Laboratories, Inc., Madison, Wis.).

The adhesivity of a polyethylene terephthalate surface is improved by treating it with a hydrolyzable vinyl silane compound and subsequently treating the surface with water.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

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Equipment

Threading Tool for Plastic. No. 2,783,-485. Harley E. Noland, Akron, and Herbert E. Hankey, Mogadore, O.

A thread cutting device comprises a frame member with a pair of angularly-disposed supporting plates; a longitudinally-extending guide means provided on one of the plates; a thread-cutting die receivable in the guide and permitting longitudinal movement therein; and a mandrel rotatably-carried by the second plate. The mandrel and the cutting die are in threaded engagement in such a manner that, upon rotation, the die will be advanced axially of the mandrel to make cutting engagement with the tubing.

Screw Extrusion Machines. No. 2,789,-498. Arthur Bruce Frazier Gillespie Richardson, Leigh, England. (to British Insulated Callender's Cables, Ltd., London, England).

A screw extrusion machine for milling and extruding thermoplastic stock comprises a feed screw whose front and rear portions are of different diameters; a tapered section joining the front and rear portions; and a barrel of corresponding form surrounding the screw. The barrel has a feed opening at its rear end; means for mounting a delivery head at its front end; means for rotatably supporting the screw in the barrel; and a means for axially adjusting the screw in the barrel to increase or decrease the clearance between the tapered portion of the screw and the surrounding tapered wall of the barrel.

Processing

Plastic Utensil Handle. No. 2,782,454. Rudi L. Baer, Roslyn Heights, N. Y.

A handle for utensils comprises a tubular member of substantially uniform thickness having an enlarged body portion from which extends a reduced body portion. The smaller opening has a diameter sufficiently large to receive a fastening member, while the large opening is plugged by a tight fitting cap. An aperture through the center of the cap admits a fastening member that extends throughout the body length. The cap and tubular member are of molded plastic materials.

Laminates and Laminated Products. No. 2,782,976. Anthonk J. Rinaldi, Demarest, and Francis A. Romano, Englewood, N. J.

A combined baking, shipping, and merchandising receptacle for goods, the container is fabricated of a laminate comprising a semi-rigid cellulosic base, a layer of moderately-parchmentized material containing a stearyl releasing agent, and a PVA adhesive.

Plastic Impeller, No. 2,782,722. Horace A. Chubbuck, Belleville, Mich. (to Ford Motor Co., Dearborn, Mich.)

A pump impeller comprising hub-supported body provided with a series of radial channels separated by bifurcated radial blades. A plurality of holes through the body are located at points intermediate between the hub and body periphery. Alternate bifurcated blades are of uniform thickness in an axial direction, while the intermediate blades are reduced in axial thickness near the hub.

Plastic Covered Insulation Product and Method for Producing Same. No. 2,782,-465. George Bruce Palmer, Jr., Grosse Pointe, Mich.

A temperature-insulating material having the shape and dimensions of a refrigerator door is enclosed within a permeable, flexible envelop which is impregnated and coated with a thermoset plastic composition. The thermoset plastic is cured under heat and temperature to provide a rigid, finished door.

Method of Making Laminated Tubing. No. 2,783, 173. Benjamin M. Walker, Caldwell, and Alexander N. T. St. John, Glen Ridge, N. J. (to Resistoflex Corp., Roseland, N. J.).

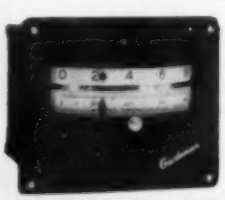
A purality of fabric layers impregnated with fluorocarbon resin are wrapped on a mandrel and tightly covered with a layer of glass fabric tape. The assembly is heated to sintering temperature to fuse the adjacent, resin-impregnated surfaces. After the laminate is cooled, it is removed from the mandrel in the form of a reinforced, fluorocarbon resin-impregnated pipe.

Method and Apparatus for Producing Flat Fiberglass Reinforced Plastic Panels. No. 2,782,458. Dale C. Emmert, El Monte, and Kenneth E. Vail, Rosemead, Calif.

A substantially flat, fiber-reinforced plastic panel is formed by an apparatus consisting of a fiber mat supply source; means for impregnating the mat with plastic; means for covering a surface of the mat with a flexible sheet; an elongated curing oven containing an arched working surface longitudinally disposed therein; a conveyor means for drawing the mat over the arched surface; and a gripping means operatively engageable with the flexible covering to apply a lateral tension. This compresses the impregnated mat during the curing operation.

Method of Laminating Plastic Materials. No. 2,783,176. James H. Boicey, Toledo, O. (to Libbey-Owens-Ford Glass Co., Toledo, O.).

At least one sheet of polyvinyl butyral is sandwiched between two sheets of acrylic, and enclosed in a plastic bag from which the air has been evacuated. The bag and contents are put into a hot liquid bath to form a laminated unit which upon removal, is oven-dried to remove wrinkles.



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Patent Digest (Cont'd.)

Applications

Means for Pneumatically Conveying Plastic Particulate Material. No. 2,784,038. George Schneider, University Heights, O. (to Dracco Corp., Cleveland, O.).

A plurality of wrinkles are formed on the internal surface of a low-pressure pneumatic conveyor conduit to interfere with continuous sliding surface contact with the plastic material being conveyed. A means also is provided to maintain an abruptly-descending velocity gradient between the main body of the airstream and the walls.

Fiber Forming Apparatus. No. 2,783,590. Charles J. Stalego Newark, O. (to Owens-Corning Fiberglas Corp., New York, N. Y.).

A container for molten glass communicates with a hollow tubular body having an opening in its lower end, and a plurality of radial vanes attached to its inner wall. The vanes extend axially through part of the body and beyond the open lower end to absorb heat from the glass and conduct it to the wall.

Apparatus for Molding Material. No. 2,783,500. Thaddeus R. L. Lazar, Greensboro, N. C. (to Western Electric Co., Inc., New York, N. Y.).

The apparatus consists of a mold with a fixed part adapted to receive a heated plastic sheet, and a moving part is secured to an elastic covering sheet. A hermetic seal is formed between the two parts, thus capturing the heated air above the plastic sheet and creating a molding pressure.

Polyurethane Cushions. No. 2,785,739. William A. McGregor, Jr., St. Louis, and James D. Mahoney, Ferguson, Mo. (to Mobay Chemical Co., St. Louis, Mo.).

A formed polyurethane seat cushion features a plurality of grooves which are wider at the top than at the bottom.

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CALENDAR of COMING EVENTS

November 18
SPE Upper Midwest Section. Worma's Cafe, Minneapolis, Minn.

SPE Southern Section. Architects & Engineers Institute, Atlanta, Ga.

November 20
SPE New York Section combined with Reinforced Plastics Group. Hotel Governor Clinton, New York City.

November 21
SPE Pittsburgh Section. Cappy's Restaurant, Pittsburgh, Pa.

SPE Rocky Mountain Section. Denver Athletic Club, Denver, Colo.

SPE Southeastern Ohio Section. Berwick Hotel, Cambridge, O.

November 25
SPE Rochester Section. Colonial Hotel, Rochester, N. Y.

November 26
SPE Philadelphia Section. Franklin Institute, Philadelphia, Pa.

November 27
SPE Quebec Section. Queens Hotel, Montreal, P. Q.

November 28
SPE Rhode Island & Southeastern Mass. Section. Wayland Manor, Providence, R. I.

December 1-6
ASME Annual Meeting. Statler & Sheraton-McAlpin Hotels, New York City.

December 5
SPE Miami Valley Section. Golden Lamb, Lebanon, O.

SPE Southern California Section. Scully's Restaurant, Los Angeles, Calif.

December 9
SPE Cleveland-Akron Section. Spanish Tavern, Brecksville, O.

SPE Chicago Section. Western Society of Engineers Building, Chicago, Ill.

December 10-11
SPI Film, Sheeting, and Coated Fabrics Division Conference. Commodore Hotel, New York City.

December 11-12
National Construction Industry Conference. Congress Hotel, Chicago, Ill.

January 28-31
SPE Annual Technical Conference. Sheraton-Cadillac Hotel, Detroit, Mich.

Domestic Production and Sales of Plastics and Resin Material, June and July, 1957

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of June and July, 1957. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

Checking against the same months in 1955 and 1956, we find cellulosics, ureas, melamines, phenolics, styrenes, coumarone-indenes, and miscellaneous resins remaining about the same. Appreciable gains are evidenced by vinyls, polyesters, and polyethylenes.

	June 1957		July 1957	
	Production	Sales	Production	Sales
Cellulose Plastics:[1]				
Cellulose acetate and mixed ester:				
Sheets, under 0.03 gage	1,795,547	1,756,065	1,390,489	1,350,789
Sheets, 0.003 gage and over	1,569,561	1,577,817	1,008,913	1,256,964
All other sheets, rods, and tubes	728,923	599,226	472,495	513,023
Molding and extrusion materials	7,793,884	7,432,770	6,620,929	6,388,154
Nitrocellulose sheets, rods, and tubes	269,720	294,840	233,087	299,297
Other cellulose plastics	468,077	421,610	340,865	262,411
TOTAL	12,605,712	12,082,328	10,066,778	10,070,638
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	13,656,147	13,163,521	12,025,031	11,858,278
Bonding and adhesive resins for—				
Laminating (except plywood)	4,986,333	3,622,693	4,098,678	3,499,813
Coated and bonded abrasives	992,285	1,026,549	965,403	1,116,692
Friction materials (brake linings, clutch facings, and similar materials)[7]				
Thermal insulation (fiber glass, rock wool)	4,644,865	4,262,815	4,699,458	4,873,648
Plywood	3,880,796	2,838,115	3,579,350	2,870,264
All other bonding and adhesive uses	4,399,887	4,131,972	4,984,569	4,444,790
Protective-coating resins, unmodified and modified except by rosin	2,431,019	1,002,315	1,513,549	1,465,432
Resins for all other uses	3,000,715	2,581,266	2,254,800	1,958,240
TOTAL	37,992,047	33,619,246	34,120,838	32,087,157
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	2,338,040	2,373,011	1,864,189	2,029,724
Paper-treating and Paper-coating resins	2,260,451	2,081,231	1,900,860	1,869,781
Bonding and adhesive resins for—				
Plywood	7,287,417	7,752,066	6,715,003	6,865,672
All other bonding and adhesive uses, including laminating	3,089,009	2,381,653	2,556,313	2,466,538
Protective-coating resins, straight and modified	2,910,985	2,375,101	2,526,992	1,748,692
Resins for all other uses, including molding	7,293,189	6,522,095	5,020,242	6,507,741
TOTAL	25,179,091	23,485,157	20,583,599	21,524,148
Styrene Resins:				
Molding materials[1]	31,393,584	24,177,628	29,006,730	32,361,204
Protective-coating resins, straight and modified	5,550,273	5,201,314	6,024,033	7,065,126
Resins for all other uses	11,915,499	8,447,974	9,882,399	8,652,739
TOTAL	48,859,356	37,826,916	44,913,162	48,079,069
Vinyl and Vinyl Chloride Resins:[2]				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		7,122,639		6,342,283
Sheeting (resin content)		4,042,561		4,362,246
Molding and extrusion (resin content)		16,962,249		14,340,496
Textile and paper treating and coating (resin content)[3]		4,744,044		5,371,617
Flooring (resin content)		6,265,311		6,029,665
Protective coating (resin content)		2,361,873		2,755,423
All other uses (resin content)		3,828,991		2,872,494
All other vinyl resins for—				
Adhesives (resin content)		4,685,159		3,236,439
All other uses (resin content)		10,163,563		7,976,241
TOTAL	68,327,479	60,176,390	63,271,556	53,286,904
Coumarone-Indene and Petroleum Polymer Resins	17,082,997	18,072,026	21,602,821	20,713,463
Polyester Resins	8,177,872	7,199,292	7,209,343	6,825,501
Polyethylene Resins	56,073,589	51,036,661	55,356,790	50,581,685
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[1, 4]	3,491,495	3,425,419	3,834,142	3,517,668
Protective-coating resins[5]	1,008,151	498,718	1,031,994	564,983
Resins for all other uses[6]	11,408,283	9,649,971	10,594,125	9,515,788
TOTAL	15,907,929	13,574,108	15,460,261	13,598,439
GRAND TOTALS	290,206,072	257,072,124	272,585,148	256,767,004

[1]Includes fillers, plasticizers, and extenders.
[2]Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3]Includes data for spreader and calendering-type resins.
[4]Includes data for acrylic, nylon, silicone, and other molding materials.
[5]Includes data for epichlorohydrin, acrylic, silicone, and other protective-coating resins.
[6]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.
[7]Included with "All other bonding and adhesive uses."
SOURCE: United States Tariff Commission, Chemical Division.

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Bakelite Division 865-6-7
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Current Market Prices

This listing is as comprehensive and up-to-date as possible. The full listing will appear three times a year, while intervening issues will carry a briefer tabulation of price changes and additions.

Companies whose products do not appear are invited to submit price data for inclusion in the listing. All suppliers are requested to submit product additions and price changes promptly as they occur, in order to make this listing of maximum value to our readers.

Prices, in general, are f.o.b. works. Ranges indicate quantity or grade variations. No guarantee of these prices is made, and spot prices should be obtained from the individual suppliers.

—The Editor

Adhesives

Ampcoflex Adhesive	gl.	$2.75 / $3.50
Bakelite BC—17613	lb.	.54 / .84
BCU-40	lb.	.18 / .48
BR-11938	lb.	.285 / .583
Bonding resins, abrasives	lb.	.20 / .915
Brake linings	lb.	.215 / .6275
Foundry resins	lb.	.2075 / .395
Heat Insul. resins	lb.	.1425/ .37
CD Cement Nos. 200, 201, 202, 203, 204	gl.	.94 / 1.50
PS-7	gl.	2.12 / 2.90
Dow Corning C-271	lb.	1.64 / 1.89
Epon Adhesive VI, VIII	lb.	3.08 / 3.30
IX	lb.	4.25 / 4.50
Epoxy Adhesive A-1, A-3, A-4	gl.	4.45 / 6.90
A-2, A-5	gl.	5.60 / 8.00
A-6	gl.	5.80 / 8.00
C-1, C-2, C-3, C-9	gl.	5.60 / 8.00
C-4, C-7	gl.	3.69 / 5.30
Flexible Resin No. 1	gl.	4.45 / 6.90
G-E 12316	lb.	.30 / .39
12353	lb.	.225 / .385
Melmac 401	lb.	.45
421	lb.	.45 / .47
Melurac 300, 302	lb.	.25 / .29
301	lb.	.28 / .33
Metlbond 2002-14	gl.	1.84 / 5.00
4021 Type I	sq. ft.	1.43
Type II	gl.	1.29 / 3.20
Type III	gl.	1.49 / 3.50
Plaskon Phenolic Bonding Resin	lb.	.16 / .21
Urea Adhesive 530-11L	lb.	.1875/ .2175
Liquid Adhesive, 2L B[1] Types	lb.	.105 / .115
WR Types	lb.	.0675/ .125
Spray Dried Adhesives	lb.	.18 / .29
Plastic Cement	gal.	2.25 / 2.70
Plobond 20	gal.	4.50 / 7.00
30	gal.	5.25 / 8.00
Polyester Foam Cement PC-232	gal.	2.40 / 2.90
Schenectady SP-7401	lb.	.29 / .31
Schwartz Vinyl Cement	gl.	1.24 / 1.50
Synvarite US #1	lb.	.195 / .215
Synvarol T	lb.	.125 / .16
T-3	lb.	.0875/ .1225
T-15, T-15D	lb.	.1275/ .1625
TN, TUN	lb.	.1325/ .1675
TN-23[1]	lb.	.14 / .175
WR-513	lb.	.0875/ .1225
WR-515	lb.	.0825/ .1175
WR-520	lb.	.0625/ .0925
Styrofoam Adhesive #5	gal.	3.75 / 4.75
Thixon CB	gal.	3.30 / 3.70
CB-2	gal.	3.75 / 3.95
IB	gal.	3.75 / 4.15
NB	gal.	4.05 / 4.45
NM-2	gal.	7.20 / 8.00
Urac 110	lb.	.205 / .225
115	lb.	.24 / .26
180	lb.	.095 / .12
185	lb.	.1625/ .2175
186	lb.	.0875/ .1125
192	lb.	.07

Anti-Static Agents

Anstac-2M	gl.	1.75 / 2.00
Logostat	gal.	1.35 / 1.65
Merix Anti-Static #79	gl.	.75 / 3.85
#79-OL	gl.	.75 / 3.85

Catalysts

Advance cobalt naphthenate 6%	lb.	.4825/ .5825
Cobalt tallate 6%	lb.	.4375/ .5375
Advasol	lb.	.4375/ .5375
Aritemp Curing Agent 105	lb.	$2.00 / 2.25
Bakelite BH-17618	lb.	.33 / $0.63
BHU-53	lb.	.15 / .45
ERL series	lb.	.67 / 1.195
Cadet benzoyl peroxide, granules	lb.	.98 / 2.00
Paste	lb.	.95 / 2.25
Powder	lb.	1.50 / 2.37
Dichlorobenzoyl peroxide	lb.	3.00 / 4.25
Lauroyl peroxide	lb.	1.90 / 3.50
Methyl ethyl ketone peroxide	lb.	1.85 / 4.00
Catalyst 57	lb.	.12
196	lb.	.10
C-110, -180, -180-S, C-110-S, WF-100, -101	lb.	.12
Celanese accelerators D & E	lb.	.43 / .50
Benzol peroxide paste	lb.	2.00
Catalyst MC-1	lb.	2.25 / 2.50
Epon Curing Agent BF_3-400	lb.	4.00 / 4.50
C-111	lb.	.6225, 1.10
D	lb.	3.33 / 4.75
T	lb.	.80 / 1.11
U	lb.	.86 / 1.02
Z	lb.	1.265 / 1.56
Furane H-736-A	lb.	1.30 / 2.00
Marblette Hardener 11	lb.	1.17 / 1.65
16, 661, 680	lb.	1.25 / 1.70
20	lb.	1.17 / 1.40
21	lb.	1.27 / 1.40
41, 665	lb.	1.32 / 1.77
175, 179	lb.	.50 / .65
645H	lb.	1.15 / 1.70
681, 901	lb.	1.20 / 1.80
900, 903	lb.	2.10 / 2.50
H C Promoter 6%	lb.	.5275/ .6275
12%	lb.	.9025/ 1.0025
Het anhydride	lb.	.55
HN 551	lb.	.95 / 1.40
901	lb.	.36 / .80
951 Ciba	lb.	.82 / 1.32
951 Furane	lb.	1.30 / 2.00
IC activators		3.00
Inhibitor	lb.	.98
Melurac 255, 259	lb.	.35
Modifier CB-110, WF-61	lb.	.15
P-27	gal.	10.00
Plaskon Hardeners, Liquid	lb.	.07
Powdered	lb.	.10 / .46
Spray dried	lb.	.10 / .25
Promoter D-2	lb.	1.60 / 2.00
Quick-Set Accelerator 804	gal.	9.80
Reichhold Hardeners 2600, 2601, 2602, 2603, 2604	lb.	.80 / 1.58
Rezolin epoxy hardeners	lb.	1.14 / 2.50
HN-951	lb.	0.86 / 1.74
SA Hardener	lb.	.10
Soligen	lb.	.4825/ .5825

Coating Resins

Acme 150, 160	lb.	2.00 / 2.50
Dispersant A	lb.	.75 / 1.00
Acryloids	lb.	.30 / .87
Amberlacs	lb.	.2625/ .2875
Amberols, phenolic types	lb.	.2125/ .375
Rosin maleic types	lb.	.21 / .345
Bakelite Phenolics	lb.	.28 / .64
Styrene emulsions	lb.	.1375/ .31
Vinyl acetates	lb.	.295 / .66
Solutions	gal.	5.10
Alcohols	gal.	2.27 / 2.76
Butyral resins	lb.	1.04 / 1.24
Chlorides	lb.	.41 / .61
Chloride-acetates	lb.	.38 / .66
Modified	lb.	.44 / .72
Celanese PVA emulsions, homopolymers	lb.	.17 / .26
Copolymers	lb.	.19 / .28
Chemigum latices	lb.	.46 / .60
Cymel 245-3	lb.	$0.38 / $0.385
245-8	lb.	.34 / .345
247-10	lb.	.385 / .39
248-8	lb.	.365 / .37
Dow Corning 805, 808	lb.	1.54 / 1.65
806	lb.	1.85 / 1.98
840	lb.	1.52 / 1.73
Dylex K-500, -600, -700, -900	lb.	.30 / .46
G-E 13110	lb.	.30 / .39
Kel-F Dispersion (dry wt.)	lb.	12.00
Ladcote FHHF-4010, FVHF-4010	lb.	.3575/ .4075
Plaskon Alkyds	lb.	.1075/ .3375
Modified	lb.	.15 / .2625
Ester Gums	lb.	.1425/ .2475
Maleics	lb.	.1825/ .275
Melamines	lb.	.195 / .435
Phenolics	lb.	.3925/ .475
Modified	lb.	.1825/ .29
Phenolic Laminating Varnishes	lb.	.165 / .27
Silicone Alkyds	lb.	1.10 / 2.40
Ureas	lb.	.195 / .435
Pliolite latices	lb.	.30 / .39
Pliolite N R	lb.	.93 / 1.22
S-3	lb.	.42 / .44
S-5	lb.	.49 / .51
Milled	lb.	.54 / .56
S-7	lb.	.88 / 1.01
Polyfluoron liquid dispersions	lb.	2.65 / 3.85
Paste dispersions	lb.	4.20 / 4.40
Primer 140	gl.	7.88 / 8.25
Reichhold Coating Resins:		
Beckacite, floor covering	lb.	.2175/ .2575
Modified phenolic	lb.	.1975/ .2475
Non-phenolic	lb.	.215 / .3175
Super, pure phenolic	lb.	.2925/ .5825
Beckamine U-F	lb.	.1975/ .35
Super, melamine	lb.	.3275/ .3975
Beckolin	lb.	.2225/ .355
Beckopol	lb.	.2525/ .2625
Beckosol Solutions, epoxy esters	lb.	.37 / .40
Modified	lb.	.18 / .23
Non-phthalic	lb.	.16 / .2325
Phenolated	lb.	.16 / .2425
Pure-drying	lb.	.1525/ .28
Non-drying	lb.	.205 / .295
Super, isophthalic	lb.	.2075/ .3025
Epoxy resin	lb.	.595 / .6975
Hard resin solutions	lb.	.115 / .195
Hydrogum	lb.	.17 / .245
Kopol	lb.	.2675/ .2725
Pentacite, non-phenolic	lb.	.17 / .2425
Plyophen phenolics, alcohol-soluble	lb.	.17 / .725
Liquid resins	lb.	.165 / .20
Powdered	lb.	.30 / .325
Solution	lb.	.2575/ .2875
Water-soluble	lb.	.111 / .30
Resin emulsions, alkyd	lb.	.23 / .27
Wallpol	lb.	.17 / .23
Styresol	lb.	.2075/ .2475
Synthe-Copal	lb.	.1625/ .20
Wallkyd	lb.	.12 / .195
Schenectady Alkyds SA Type	lb.	.3575/ .38
SE Type	lb.	.3675/ 1.435
SEA Type	lb.	.3575/ .38
Styrenated	lb.	.22 / .2625
Maleics	lb.	.1725/ .23
Phenolics	lb.	.2325/ .53
Modified	lb.	.1825/ .275
Schwartz AT-25	gl.	.63 / 1.00
BK-40	gal.	3.80 / 3.95
Versamid 100	lb.	.51 / .69
115	lb.	.64 / .82

Colors

Acheson 0100 Series Paste Dispersions:		
Blacks	lb.	.50 / .81
Blues	lb.	.55 / 2.175
Green	lb.	2.51 / 2.69
Orange	lb.	.67 / .85
Reds	lb.	1.08 / 1.34
White	lb.	.52 / .70
Yellows	lb.	.57 / .75
Advabrite M-10	lb.	2.25 / 2.40
Advance Brightener M.D.A.C.	lb.	12.00 / 15.00
Akron Chemical Colors:		
Dry blends, reds	lb.	1.08 / 1.23
Yellows	lb.	.58 / .88
Organic colors, blues	lb.	.75 / 3.60
Greens	lb.	1.35 / 3.95
Reds	lb.	1.10 / 4.40
Yellows	lb.	2.00 / 5.00
Pastes, blues	lb.	1.25 / 1.58
Greens	lb.	1.85 / 1.90
Reds	lb.	1.10 / 1.40
White	lb.	.55 / .60
Yellows	lb.	1.70 / 1.75
Cabot carbon blacks:		
Black pearls 2	lb.	.70 / .78
71	lb.	.32 / .40
74	lb.	.24 / .32
81	lb.	.084 / .135
0	lb.	.12 / .19
Carbolac 2	lb.	.70 / .79
Elf 0	lb.	.12 / .19
Elftex 3, 5, 8	lb.	.085 / .135

Monarch 71	lb.	$0.32 /	$0.40
74	lb.	.24 /	.32
81	lb.	.095 /	.16
Sterling R	lb.	.0525/	.0925
S	lb.	.045 /	.0875
Supercarbovar	lb.	.47 /	.54
Cadmolith Reds	lb.	1.72 /	2.20
Yellows	lb.	1.12 /	1.20
California Ink, P. C. color dispersions:			
Black	lb.	.76 /	.77
Blues	lb.	.90 /	2.17
Brown	lb.	.56 /	.57
Green	lb.	2.05 /	2.06
Reds	lb.	.61 /	2.67
White	lb.	.72 /	.73
Yellows	lb.	.62 /	.74
P. C. plasticized boat colors:			
Black	lb.	.76 /	.77
Blue	lb.	1.32 /	1.33
Blue-green	lb.	1.21 /	1.22
Green	lb.	2.12 /	2.13
Red	lb.	2.69 /	2.70
Yellow	lb.	1.71 /	1.71
Claremont 4000-Series Pastes:			
Blacks	lb.	.82 /	1.01
Blue	lb.	.80	
Browns	lb.	.65 /	2.30
Greens	lb.	.80 /	2.15
Orange	lb.	1.58	
Reds	lb.	5.60 /	6.95
Silver	lb.	1.02	
White	lb.	.715	
Yellows	lb.	.65 /	2.87
D-Series pastes,			
Blacks	lb.	.48 /	.64
Blues	lb.	.62 /	1.57
Browns	lb.	.48 /	1.67
Golds	lb.	2.31 /	2.49
Green	lb.	1.78 /	1.88
Oranges	lb.	.71 /	4.27
Reds	lb.	1.10 /	6.36
Silver	lb.	.89 /	.91
Whites	lb.	.47 /	.60
Yellows	lb.	.56 /	3.70
K-Series pastes,			
Blacks	lb.	.56 /	.71
Blues	lb.	.89 /	1.40
Browns	lb.	.53 /	.55
Greens	lb.	.92 /	1.41
Metallics	lb.	.89 /	2.47
Orange	lb.	.86 /	4.45
Reds	lb.	.99 /	6.85
Violets	lb.	2.28 /	2.30
Whites	lb.	.59 /	.60
Yellows	lb.	.72 /	3.02
MB-Series inks:			
Black	lb.	.85	
Blue	lb.	1.25	
Clears	lb.	.65 /	.66
Green	lb.	1.30	
Metallics	lb.	1.20 /	1.25
Orange	lb.	1.05	
Pearl	lb.	1.17	
Red	lb.	1.11	
White	lb.	.68	
Yellows	lb.	.90 /	1.23
MY Series Inks:			
Black	lb.	.70	
Blue	lb.	1.25	
Clears	lb.	.57 /	.62
Green	lb.	1.35	
Greengold	lb.	1.90	
Orange	lb.	.85	
Pearlescent	lb.	1.95	
Reds	lb.	1.15 /	2.95
White	lb.	.55	
Yellows	lb.	.75 /	1.35
Mylar printing inks:			
Aluminum	lb.	.99	
Black	lb.	.81	
Blue	lb.	1.18	
Bronze reducing clear	lb.	.51	
Gold concentrate	lb.	1.07	
Green	lb.	1.27	
Hi-viscosity clear	lb.	.69	
Orange	lb.	.97	
Pearlescent concentrate	lb.	1.98	
Red	lb.	1.19	
Reducing clear	lb.	.68	
White	lb.	.53	
Yellows	lb.	.83 /	1.21
PE-Series, granular concentrates:			
Blacks	lb.	.86 /	1.05
Blues	lb.	2.98	
Green	lb.	3.00	
Metallics	lb	1.27 /	1.66
Oranges	lb	1.12 /	2.75
Reds	lb	1.93 /	5.25
Whites	lb.	.70 /	.85
Yellows	lb.	.78 /	5.10
PX-Series pastes:			
Black	lb.	1.58 /	1.68
Blue	lb.	2.50 /	2.60
Browns	lb.	1.08 /	1.47
Green	lb.	2.76 /	2.86
Grey	lb.	1.30 /	1.40
Ochre	lb.	1.27 /	1.37
Orange	lb.	1.48 /	1.58
Silver	lb.	1.45 /	1.55
White	lb.	.91 /	1.01
Yellows	lb.	1.58 /	2.55
RP-Series inks:			
Aluminum	lb.	$0.89	
Black	lb.	.58	
Blue	lb.	1.08	
Gold	lb.	.95	
Green	lb.	1.12	
Orange	lb.	.83	
Pearlescent	lb.	1.87	
Red	lb.	1.08	
Reducing clears	lb.	.47 /	.65
White	lb.	.49 /	
Yellows	lb.	.71 /	1.09
UR-Series pastes:			
Black	lb.	1.00	
Blue	lb.	1.82	
Brown	lb.	2.00	
Green	lb.	2.20	
Orange	lb.	1.68	
Reds	lb.	1.92 /	3.55
White	lb.	.83	
Yellows	lb.	1.75 /	2.15
VC-Series Inks:			
Black	lb.	.56	
Blue	lb.	.68 /	1.15
Clear	lb.	.39 /	.55
Green	lb.	1.155	
Metallics	lb.	.72 /	1.54
Orange	lb.	.68	
Pearl	lb.	1.96	
Red	lb.	1.17	
White	lb.	.37	
Yellows	lb.	.61	
VC-Series Inks, arc resistant:			
Black	lb.	.68	
Blues	lb.	.79 /	1.05
Clears	lb.	.51 /	.53
Greens	lb.	.80 /	1.17
Metallics	lb.	.74 /	1.37
Orange	lb.	.81	
Reds	lb.	1.08	
Violet	lb.	.96	
White	lb.	.54	
Yellows	lb.	.69 /	1.15
Columbian Carbon colors:			
Aqueous dispersions			
Aquablak No. 1	lb.	.1925/	.1975
3	lb.	.125 /	.13
15	lb.	.115 /	.12
26	lb.	.1025/	.1125
41	lb.	.34 /	.345
B	lb.	.0975/	.1025
G	lb.	.12 /	.125
H	lb.	.20 /	.205
K	lb.	.12 /	.125
L	lb.	.14 /	.145
M	lb.	.105 /	.11
S	lb.	.1175/	.1225
U	lb.	.225 /	.23
X	lb.	.11 /	.115
Coloidex No. 3	lb.	.14 /	.21
No. 8	lb.	.16 /	.23
Hiblak AE	lb.	.095 /	.11
Colloidal dispersions			
Coacetateblak CQ-21	lb.	.875 /	.90
Coblac 405	lb.	.90 /	.925
DD Sol.	lb.	.70 /	.725
Industrial	lb.	.70 /	.725
Coethloblak CK	lb.	1.00 /	1.025
Coresinblak No. 3	lb.	.76 /	.785
Costyreneblak 903	lb.	.595 /	.62
CJ-21	lb.	.5425/	.5675
Covarnishblak AR	lb.	.60 /	.625
BK	lb.	.53 /	.555
BJ	lb.	.50 /	.525
Covinylblak BA	lb.	.95 /	.975
BD	lb.	.97 /	.995
BF	lb.	.70 /	.725
BH	lb.	.66 /	.685
BL	lb.	.82 /	.845
BM	lb.	.77 /	.795
CA-18	lb.	1.0725/	1.0975
Cowaxblak BV-25	lb.	.515 /	.54
CB-18	lb.	.5875/	.6125
CM-83	lb.	.485 /	.51
DC Globak	lb.	.77 /	.795
DCY Coblac	lb.	.83 /	.855
Mapico colors, black	lb.	.1475/	.15
Browns	lb.	.1575/	.16
Crimsons, reds	lb.	.1425/	.145
Tans	lb.	.2325/	.235
Yellows	lb.	.12 /	.1275
Paint grades			
140	lb.	.1025/	.18
999	lb.	.26 /	.34
Excelsior	lb.	.135 /	.21
Molacco	lb.	.0625/	.12
Beads	lb.	.0575/	.115
Neo Spectra MK. 1	lb.	.98 /	1.07
MK. 11	lb.	.78 /	.87
MK. 111	lb.	.47 /	.55
Ravens 11 & 15	lb.	.1025/	.18
Beads	lb.	.0775/	.17
Royal Spectra	lb.	1.66 /	1.78
Statex	lb.	.0725/	.13
Beads	lb.	.0625/	.12
Super Spectra	lb.	.70 /	.79
Superba	lb.	.36 /	.44
Continex HAF	lb.	.0725/	.13
SRF	lb.	.0525/	.11
Cyanamid inorganic pigments:			
Cobalt blues	lb.	.28 /	.35
Chrome greens	lb.	.42 /	.47
Oranges	lb.	.35	
Yellows	lb.	$0.35	
Iron blues	lb.	.54/	.59
Molybdate chrome oranges	lb.	.48	
Ultramarine blues	lb.	.19 /	.325
Zinc yellow	lb.	.29	
Powders, Unitane-O	lb.	.255 /	.265
Unitane-OR	lb.	.275 /	.285
Organic dyes, Indulines	lb.	.89 /	1.07
Nigrosines	lb.	.65 /	.94
Oil-soluble black	lb.	.68	
Blue	lb.	8.02	
Orange	lb.	1.06	
Reds	lb.	1.49 /	2.28
Yellows	lb.	1.21 /	4.16
Spirit-soluble black	lb.	2.95	
Brown	lb.	5.30	
Orange	lb.	5.87	
Red	lb.	6.41	
Yellows	lb.	4.62 /	4.94
Pigments, alkali blues	lb.	1.28 /	2.25
Benzidine oranges	lb.	3.15	
Yellows	lb.	.65 /	3.25
Bon reds	lb.	1.50 /	2.00
Carteret red	lb.	.93	
Chlorinated para reds	lb.	1.30	
Clarion orange	lb.	1.65	
Red	lb.	1.30	
Dinitraniline oranges	lb.	1.50	
Fugitive peacock-blue lakes	lb.	.90 /	1.17
Hansa yellows	lb.	2.20	
Lithol reds	lb.	.93 /	.98
Methyl violet toner	lb.	1.31	
Naphthol reds	lb.	.80 /	3.70
Orange lakes	lb.	.85 /	.90
PTMA blue	lb.	5.55	
Greens, Lincoln	lb.	5.30 /	6.60
Violet	lb.	4.35	
Para reds	lb.	1.15	
Phloxine toner	lb.	1.75	
Phthalocyanine blues	lb.	.90 /	4.20
Greens	lb.	3.50 /	3.95
Pigment green	lb.	1.35	
Scarlet	lb.	1.65	
Red Lake C's	lb.	1.20	
Madder	lb.	3.10	
Rhodamines	lb.	6.60	
Toluidine reds	lb.	1.70	
Yellow lakes	lb.	1.05 /	1.15
DC Globak	lb.	.77 /	.795
DCY Coblac	lb.	.83 /	.855
Eagle-Picher Basic carbonate White lead	lb.	.19 /	.20
Basic silicate, white lead			
201	lb.	.2075/	.2175
202	lb.	.20 /	.21
Litharge	lb.	.19	
Sublimed	lb.	.1910	
Ferro inorganic colors:			
Black	lb.	1.25 /	1.40
Blues	lb.	1.91 /	2.96
Blue-greens	lb.	1.85 /	2.85
Browns	lb.	.90 /	1.31
Oranges	lb.	2.29 /	4.20
Pink	lb.	1.77 /	1.92
Reds	lb.	2.96 /	4.75
Violets	lb.	1.89 /	2.47
Yellows	lb.	1.26 /	2.90
Harwick Stan-Tones, blues			
Dry	lb.	.90 /	3.45
GPE	lb.	2.50 /	2.85
MBS	lb.	2.20 /	4.55
PC	lb.	1.55 /	1.92
Brown, GPE	lb.	3.00	
PC	lb.	.60 /	.74
Greens, dry	lb.	.82 /	3.95
GPE	lb.	1.85 /	3.00
MBS	lb.	1.15 /	3.42
PC	lb.	1.70 /	2.32
Oranges, cadmium dry	lb.	2.10 /	5.05
Paste	lb.	2.52 /	3.32
GPE	lb.	1.20 /	1.27
MBS	lb.	1.25 /	2.82
PC	lb.	.75 /	.94
Reds, cadmium dry	lb.	2.26 /	6.15
Paste	lb.	2.25 /	4.05
Dry	lb.	.85 /	4.60
GPE	lb.	1.65 /	3.15
MBS	lb.	1.00 /	3.25
PC	lb.	1.02 /	1.52
Yellows, cadmium dry	lb.	2.80 /	3.18
Paste	lb.	1.79 /	2.21
Dry	lb.	.66 /	2.45
GPE	lb.	2.00 /	4.50
MBS	lb.	1.85 /	2.27
PC	lb.	.55 /	3.50
Hiblak AE	lb	.095 /	.10
Huber pigments:			
WVEX, EPC	lb.	.0725/	.135
Zeolex 7	lb.	.085 /	.095
23	lb.	.06 /	.07
Interchemical IC Series			
Black	lb.	.56	
Blues	lb.	.75 /	2.10
Browns	lb.	.64 /	.69
Greens	lb.	.90 /	.99
Oranges	lb.	.78 /	.89
Reds	lb.	1.16 /	2.50
White	lb.	.70	
Yellows	lb.	.95 /	1.65
Kentucky inorganics, orange	lb.	.44 /	.64

Yellows	lb.	$0.31 /	$0.66
Organics	lb.	3.00 /	4.15
Greens	lb.	3.50 /	4.60
Purple	lb.	1.85 /	2.05
Reds	lb.	1.95 /	3.85
Kriegr-O-Dip W Types	gl.	2.63 /	7.80
A Types	gl.	1.52 /	2.25
Laminac color pastes	lb.	.76 /	1.90
Mearlmaid Pearls	lb.	14.00 /	25.00
Nacromer Pearls, Series C	lb.	2.15 /	2.25
Series W	lb.	1.50 /	1.60
Pearl Essence, nat	lb.	10.00 /	21.00
Synthetic 100	lb.	2.25 /	2.50
200, 300	lb.	1.30 /	1.45
1000	lb.	2.05 /	2.15
1025	lb.	3.60 /	4.00
2100	lb.	3.30 /	3.45
RAL	lb.	2.15 /	2.45
NLY, non-lead	lb.	3.40 /	3.50
Plastics Color Co., GP colors:			
Blacks	lb.	.75 /	3.80
Blues	lb.	.445 /	.48
Brown	lb.	1.20 /	2.25
Greens	lb.	.65 /	3.50
Reds	lb.	.65 /	3.50
Whites	lb.	.75 /	1.10
Yellows	lb.	1.15 /	1.95
Dispersant 3000	lb.	.50 /	.70
3005	lb.	.40 /	.60
3007	lb.	.80 /	1.00
3008	lb.	.55 /	.75
Special acrylic pastes:			
Aqua, Ivory	lb.	1.15	
Black	lb.	1.90	
Blues	lb.	1.10 /	1.25
Brown, White	lb.	1.05	
Green	lb.	1.55	
Grey, Pink	lb.	1.25	
Red	lb.	2.45	
Yellow	lb.	1.50	
Transparent acrylic pastes:			
Amber	lb.	1.60	
Green	lb.	1.80	
Red	lb.	1.95	
Violet	lb.	2.00	
Yellow	lb.	1.50	
Polyester pastes, aqua	lb.	1.65	
Beige	lb.	1.45	
Black	lb.	1.10	
Blues	lb.	1.20 /	1.30
Brown	lb.	1.35	
Greens	lb.	1.20 /	1.70
Grey	lb.	1.30	
Ivory	lb.	1.30	
Oranges	lb.	1.80 /	2.05
Red	lb.	2.35	
White	lb.	.80	
Yellow	lb.	1.60	
Pliolite S-5 bases with pigment			
Blacks	lb.	.44 /	.49
Blues	lb.	.62 /	1.48
Greens	lb.	.54 /	.58
Oranges	lb.	.61 /	.63
Reds	lb.	.31 /	1.20
Whites	lb.	.42 /	.44
Yellows	lb.	.43 /	.45
PMS polyester colors	lb.	.85 /	2.85
Polystyrene colors	lb.	.65 /	4.30
Polysupra polyethylene blues	lb.	.65 /	5.60
Blacks	lb.	.50 /	.80
Browns	lb.	1.48 /	3.30
Greens	lb.	1.82 /	3.55
Ivory	lb.	.65 /	1.00
Purples	lb.	2.10 /	3.30
Reds	lb.	.70 /	6.30
Silver	lb.	1.50 /	2.95
White	lb.	.60 /	.85
Yellow	lb.	1.45 /	4.25
Polystyrene blues	lb.	.50 /	9.20
Blacks	lb.	.50 /	5.30
Browns	lb.	.95 /	2.55
Greens	lb.	.35 /	7.40
Ivory	lb.	.85 /	1.20
Reds	lb.	.35 /	6.40
White	lb.	.60 /	1.05
Yellows	lb.	1.45 /	2.95
R-B-H Plastic Powders:			
Blacks	lb.	.66 /	.85
Blues, iron	lb.	.825 /	.925
Phthalocyanines	lb.	2.68 /	2.78
Browns	lb.	.56 /	.92
Greens, chrome	lb.	.805 /	.905
Phthalocyanines	lb.	2.29 /	2.39
Orange	lb.	.82 /	.92
Purple	lb.	2.95 /	3.05
Red	lb.	1.88 /	1.98
Whites	lb.	.66 /	.76
Yellow	lb.	.76 /	.86
Resin Plasticizer Pastes:			
Blacks	lb.	.56 /	.675
Blue	lb.	1.61 /	1.62
Green	lb.	1.60 /	1.61
Orange	lb.	.685 /	.695
Reds	lb.	1.19 /	2.15
White	lb.	.505 /	.515
Yellows, cadmium	lb.	1.22 /	1.23
Chrome	lb.	.565 /	.575
Vinyl Extrusion Chips:			
Blacks	lb.	.895 /	1.09
Blues, iron	lb.	.85 /	1.13
Phthalocyanine	lb.	2.45 /	2.55
Brown	lb.	.83 /	.93
Green, chrome	lb.	.91 /	1.01
Phthalocyanine	lb.	2.46 /	2.56
Oranges	lb.	.825 /	.97
Purple	lb.	$3.36 /	$3.46
Reds	lb.	1.65 /	2.07
White	lb.	.73 /	.83
Yellow	lb.	.795 /	.895
R-C blacks	lb.	5.50 /	21.30
Browns	lb.	4.375 /	15.75
Reds	lb.	.28 /	15.05
Yellows	lb.	3.60 /	14.05
Reichhold inorganic pigments:			
Blues, iron	lb.	.53	
Milori, pre-wet	lb.	.3625	
Greens, chrome	lb.	.42 /	.44
Reduced 25%	lb.	.19	
Oranges, chrome	lb.	.35	
Molybdate	lb.	.48	
Yellows, chrome	lb.	.35	
Zinc	lb.	.29 /	.34
Rez-N-Dye (dry wt.)	lb.	7.50	
Saran colors	lb.	.59 /	1.80
Sherwin-Williams Dispersed Colors	lb.	.55 /	1.97
Inorganic colors, oranges, yellows	lb.	.32 /	.45
Organic colors, blues	lb.	.90 /	3.60
Greens	lb.	1.35 /	3.95
Reds	lb.	.85 /	4.40
Yellows	lb.	.55 /	1.97
Vansul Organic Drys			
Blues	lb.	3.45 /	3.60
Greens	lb.	1.35 /	3.95
Oranges	lb.	2.21 /	3.00
Reds	lb.	.90 /	4.40
Yellows	lb.	2.00 /	2.25
VAP Dry Dispersions			
Black	lb.	1.00	
Blues	lb.	2.90 /	3.60
Greens	lb.	3.20 /	4.05
Oranges	lb.	1.45 /	2.55
Reds	lb.	1.70 /	4.45
Yellows	lb.	1.35 /	2.55
VP-Series Pastes			
Black	lb.	.70	
Blue	lb.	1.65	
Brown	lb.	1.55	
Green	lb.	2.05	
Oranges	lb.	.80 /	2.30
Reds	lb.	1.15 /	2.55
White	lb.	.47 /	.65
Yellows	lb.	.60 /	1.65
VPE-Series Pastes			
Black	lb.	.90	
Blue	lb.	1.85	
Green	lb.	2.10	
Orange	lb.	1.00	
Reds	lb.	1.45 /	2.30
White	lb.	.90	
Yellows	lb.	1.60 /	2.00
VY Chips			
Blacks	lb.	.90 /	1.30
Blues	lb.	1.00 /	2.25
Brown	lb.	1.60	
Greens	lb.	.90 /	2.45
Oranges	lb.	1.00 /	2.15
Reds	lb.	1.40 /	2.70
White	lb.	.65	
Yellows	lb.	.85 /	1.80
Vinylized colors, blacks, whites	lb.	.755	
Blues	lb.	1.16 /	1.18
Golds	lb.	1.51	1.57
Green	lb.	1.45	
Metallic	lb.	1.15	
Orange	lb.	.83	
Reds	lb.	1.15	1.27
Yellows	lb.	.76	1.09
Violite 199, green	lb.	2.95	
200, yellow	lb.	3.75	
PL 3-60, blue	lb.	3.25	
18-70, blue	lb.	3.70	
Williams colors & pigments:			
Blacks, iron oxide	lb.	.1425/	.145
Browns, iron oxide	lb.	.1525/	.155
Burnt umbers	lb.	.0775/	.095
Greens, chromium oxide	lb.	.42 /	.4875
Reds, 100 series, 1,000 series, RY series	lb.	.1375/	.14
Kromas	lb.	.1375/	.15
Yellows, iron oxide	lb.	.115 /	.1225
Witcoblak 12	lb.	.0725/	.14
32	lb.	.1225/	.20
50	lb.	.0975/	.175
100	lb.	.26 /	.34
Pellets	lb.	.26 /	.34
F-1	lb.	.0575/	.12
Hitone	lb.	.36 /	.44
Pellets	lb.	.36 /	.44
Zopaque, anatase	lb.	.255 /	.265
Rutile	lb.	.265 /	.285

Dispersing Agents

Daxads	lb.	.08 /	.40
Tamol 731	lb.	.185 /	.1875

Fillers

Advaresin CXF	lb.	.49 /	.55
KF	lb.	.38 /	.44
A. F. D.	ton	26.50 /	60.00
Albacar 5950, 5960, 5970	ton	50.00 /	55.00
Aluminum Flake	ton	23.50 /	30.00
Anhydrous calcium sulfate, W-1320	ton	$47.00 /	$52.00
Atomite	ton	32.50	
Barytes, No. 1	ton	45.00 /	65.75
Burgess Iceburg Pigment	ton	50.00	
Pigment No. 30	ton	37.00	
Cab-o-sil	lb.	0.68 /	0.75
Calcene NC	lb.	.036 /	.059
TM	lb.	.0375/	.0625
Camel—CARB	ton	12.00	
—TEX	ton	20.00	
—WITE	ton	32.50	
Cotton flocks	lb.	.12 /	.32
Crown Clay	ton	14.00	
Dixie Clay	ton	14.00 /	34.50
Duramite	ton	20.00	
English Mica:			
Waterground mica 160 mesh	lb.	.08 /	.0875
325 mesh	lb.	.0825/	.09
Georgia Kaolin clays:			
Hydrite	ton	26.00	
Flat	ton	25.00	
PD-10	ton	49.00	
PD-121	ton	20.00	
PX	ton	41.00	
Harwick fillers:			
Clays, Champion	ton	14.00 /	36.00
Harwick	ton	20.50 /	55.50
Flock, white	lb.	.11 /	.28
Colored	lb.	.11 /	.19
Magnesium carbonate	lb.	.105 /	.13
Magnesia, tech.	lb.	.055 /	.345
Mica, Silversheen	lb.	.08 /	.0875
Pecan shell flour	ton	45.00 /	106.00
Stan white 325	ton	11.50 /	23.50
Walnut shell flours:			
100W, 200WD	ton	50.00 /	60.00
200W	ton	60.00 /	70.00
200WB	ton	62.00 /	72.00
325W	ton	74.00 /	84.00
Hi-Sil 101	lb.	.10 /	.155
233	lb.	.09 /	.105
Huber Clays:			
Coating grade X-44	ton	21.00 /	26.00
Hydrasperse	ton	21.50 /	34.00
Hi-White R	ton	18.50	
Paragon	ton	14.50 /	18.50
Polyfil	ton	20.00	
Suprex	ton	14.00 /	19.00
Water-washed SWW, CWF	ton	12.00 /	17.00
Kalite	ton	50.00 /	65.00
Kaolloid	ton	10.50	
Laminar	lb.	.015	
Maglite	lb.	.2525/	.26
Marinco	lb.	.105 /	.13
McMamee Clay	ton	13.50 /	33.00
Minerals & Chemical Corp.:			
Edgar ASP 200	ton	43.00	
ASP 400	ton	24.00	
ASP 600	ton	25.00	
ASP 900	ton	19.50	
ASP 1300	ton	80.00	
Multiflex MM	ton	110.00 /	125.00
Nytal 200L	ton	27.00 /	50.00
300	ton	37.00 /	60.00
Omya BSH	ton	45.00	
Secco Clay	ton	12.00	
Silene EF	lb.	.06 /	.105
Sno-Brite Clay	ton	12.50	
Snowflake	ton	20.00	
Sparmite	ton	80.00 /	105.00
Surtex MM	ton	37.00 /	52.00
Suspenso	ton	33.00 /	48.00
Tamms Satin Talc	ton	22.50 /	46.00
Velveteen R Silica	ton	23.00 /	28.00
U.S. Mica, dry grind	lb.	.04 /	.065
Witcarb P	ton	110.00 /	140.00
R	ton	120.00 /	150.00
Regular	ton	56.75 /	85.00
Wollastonite F-1	ton	23.00 /	25.00
P-1	ton	25.00 /	27.00

Finishes

Logoquant colors	gal.	3.25 /	6.30
Toy gloss, acetate	gal.	2.35 /	4.30
Metal	gal.	2.45 /	4.10
Polystyrene	gal.	2.45 /	4.70

Flame-Proofing Agents

IC-776 Antimony Concentrate	lb.	.495 /	.51
M&T Antimony oxide	lb.	.27 /	.285

Glass Reinforcements

Chrome 60-end Roving:			
FBF-7.1, -7.3	lb.	.40 /	.44
FBF-7.5, -7.7	lb.	.42 /	.46
Garan 60-end Roving:			
FBF-7.2, -7.4	lb.	.42 /	.46
FBF-7.6, -7.8	lb.	.44 /	.48
Vitron 60-end Roving:			
VR-12	lb.	.48 /	.52

Lubricants

Advawax 280	lb.	$0.365 /	$0 39
Baselube	gl.	2.50 /	4.00
Dow Corning 7 Compound	lb.	5.30 /	6.50
20 Compound	lb.	1.74 /	4.95
20 Emulsion	lb.	.90 /	3.50
36 Emulsion	lb.	1.22 /	1.40
Mold Release Fluid	lb.	3.20 /	4.75
Garalease 915	gal.	3.80 /	4.50
GE silicone-emulsions	lb.	1.22 /	1.40
HSC #35, 362, 515	lb.	1.22	
IC-500	gal.	2.50	
-571	gal.	3.25	
-793-10	gal.	3.40	
IMS neutral oil spray	can	1.37 /	2.00
Lubrex	lb.	.27 /	.32
Lunn-Lease	gal.	3.80 /	4.25
M-1 Mold Release	lb.	3.00 /	4.00
Metasap barium stearate	lb.	.37 /	.42
Calcium 627	lb.	.36 /	.41
Stearate	lb.	.35 /	.40
Magnesium stearate	lb.	.38 /	.43
ML-4 Separating Film	lb.	.30 /	.40
Mold-Ease Concentrate PCR	qt.	2.50 /	5.85
Mold Release 225	gal.	5.25 /	6.00
235	gal.	6.00	
Mold-Wiz	gal.	4.00 /	6.00
Part-A-Part	gal.	3.05 /	3.75
Partingkote 823	qt.	1.18 /	2.18
Prepoxy	gal.	7.20 /	12.80
Plaskon 8406, 8407	lb.	.30 /	.37
8416, 8417	lb.	.35 /	.42
8429	lb.	.40 /	.47
Poly-Lease 77	16 oz.	1.40 /	1.50
Releasor Wax No. 826	lb.	2.29	
Slide	20 oz.	1.25 /	2.00
Sprits	20 oz.	1.00 /	1.25
SS-452	gal.	2.80 /	4.90
Super King Bomb-Lube	20 oz.	1.75 /	2.50
Toplube	qt.	2.50 /	4.00
Vibrin-VPA Parting Agent	gal.	4.25 /	4.65

Mica

Dry Ground Mica	lb.	.04 /	.065
Mycalex 385 & 400, rods, 18 in. length		.90 /	3.35
Sheets, 14 x 18 inches		5.70 /	22.40
K, rods, 18-in. length		1.80 /	6.70
Sheets, 14 x 18 inches		11.40 /	44.80
Supramica 500, rods, 18-in. length		1.08 /	4.02
Sheets, 14 x 18 inches		6.84 /	26.88
Waterground Mica	lb.	.08 /	.09

Miscellaneous

Dutch Boy Bentone	lb.	.44 /	.60
Ben-A-Gel	lb.	.98 /	1.40
Metasap Water Proofing Agent 569	lb.	.21	
PMS Purging Compound	lb.	.35	
Ultra violet absorber #9	lb.	5.25 /	5.75

Plasticizers

Adipol 2EH, 10A, 810, XX	lb.	.40 /	.435
BCA	lb.	.43 /	.455
ODY	lb.	.45 /	.465
Admex	lb.	.3325/	.3625
711	lb.	.3525/	.3825
744, 745	lb.	.3925/	.4225
760	lb.	.5725/	.6025
761	lb.	.4425/	.4725
562	lb.	.4825/	.5125
Akron MP	lb.	.305	
Araldite No. 1	lb.	.765 /	1.55
Arnold-Hoffman butyl oleate	lb.	.20 /	.30
Butyl stearate	lb.	.2275/	.2675
Barrett dibutyl phthalate	lb.	.30 /	.335
Dimethyl phthalate	lb.	.28 /	.315
Plasticizer 136	lb.	.175 /	.21
Benzoflex 2-45	lb.	.26 /	.29
9-88	lb.	.32 /	.35
Cabflex DDA, Di-OA, DOA, ODA	lb.	.425 /	.455
DDP, DI-OP, DOP, ODP	lb.	.305 /	.335
Di-BA	lb.	.4325/	.4625
Di-OZ	lb.	.48 /	.51
HS-10	lb.	.44 /	.47
TCP	lb.	.345 /	.375
Chlorowax 40	lb.	.1525/	.1825
50	lb.	.1675/	.1875
70	lb.	.185 /	.25
70-S	lb.	.21 /	.275
LV	lb.	.1725/	.2025
Columbian Carbon butyl stearate	lb.	.2375/	.3275
Capryl alcohol	lb.	.195 /	.30
Caprylene	lb.	.10 /	.205
Dibenzyl sebacate	lb.	.92 /	1.01
Dibutyl phthalate	lb.	.30 /	.395
Dibutyl sebacate, CP	lb.	.665 /	.755
Dicapryl phthalate	lb.	.27 /	.36
Dihexyl adipate	lb.	.40 /	.495
Dihexyl phthalate	lb.	.30 /	.395
Dihexyl sebacate	lb.	$0.65 /	$0.74
Diisodecyl phthalate	lb.	.29 /	.385
Diisooctyl adipate	lb.	.40 /	.495
Diisooctyl phthalate	lb.	.28 /	.375
Diocytl adipate	lb.	.40 /	.495
Dioctyl phthalate	lb.	.28 /	.375
Dimethyl sebacate	lb.	1.30 /	1.39
Dioctyl sebacate	lb.	.60 /	.69
Harchemex	lb.	.24 /	.345
Harflex 300	lb.	.58 /	.675
325	lb.	.4325/	.52
500	lb.	.315 /	.41
Isooctyldecyl phthalate	lb.	.285 /	.38
Methyl ethyl ketone	lb.	.26 /	.365
Sebacic acid, CP	lb.	.77 /	.89
Purified	lb.	.69 /	.81
Conoco H-300	lb.	.06 /	.10
Darex DIBA	lb.	.4325/	.4625
DIBM	lb.	.32 /	.3475
DIBP	lb.	.30 /	.33
DODA, DIOA	lb.	.425 /	.455
DIDP, DIOP, DOP, DOP-HR, IOIDP	lb.	.305 /	.335
Dinopol 235	lb.	.335 /	.37
IDO	lb.	.285 /	.32
MOP	lb.	.31 /	.345
Dow Plasticizer No. 5	lb.	.315 /	.54
Resin 276-V2,-V9	lb.	.265 /	.325
Drapex 3.2	lb.	.40 /	.49
Drew DP-100, DP 200	lb.	.425 /	.46
DP-250	lb.	.435 /	.47
DP-316	lb.	.30 /	.335
DP-317	lb.	.5625/	.5975
DP-520	lb.	.4225/	.4575
SC	lb.	.44	
Dutch Boy Plasticizer NL-A10 (DBP)	lb.	.30	.33
NL-A20 (DOP), NL-A30 (DIOP)	lb.	.305 /	.335
NL-C20 (DOS)	lb.	.61 /	.63
NL-F21	lb.	.395 /	.425
NL-F31	lb.	.44 /	.47
NL-F41	lb.	.48 /	.51
NL-A54	lb.	.295 /	.325
Eastman di(2 ethyl hexyl) adipate, P.E.	lb.	.40 /	.435
Di (2 ethyl hexyl) azelate	lb.	.455 /	.49
Di-(2 ethyl hexyl) phthalate	lb.	.28 /	.315
Di(methoxy ethyl) phthalate	lb.	.425 /	.46
Diisobutyl adipate	lb.	.41 /	.445
Dibutyl phthalate	lb.	.30 /	.335
Diethyl phthalate	lb.	.275 /	.31
Diisobutyl phthalate	lb.	.29 /	.325
Dimethyl phthalate	lb.	.28 /	.315
Plasticizer 84	lb.	.27 /	.305
Triacetin	lb.	.365 /	.40
Tributyrin	lb.	.69	
Elastex 10-P, 28-P	lb.	.28 /	.315
18-P	lb.	.285 /	.32
20-A, 60-A	lb.	.40 /	.435
40-P, 48-P	lb.	.27 /	.305
50-B	lb.	.265 /	.30
80-P	lb.	.275 /	.31
90-P	lb.	.29 /	.325
DCHP, cast solid	lb.	.58 /	.59
Granular	lb.	.595 /	.605
Ethox	lb.	.50 /	.525
Flexol 3GH	lb.	.44 /	.46
3G0	lb.	.53 /	.55
4G0	lb.	.325 /	.35
8N8	lb.	.355 /	.38
10-10, 10-A	lb.	.29 /	.315
77-G, 426	lb.	.27 /	.295
380	lb.	.305 /	.33
810	lb.	.285 /	.31
A-26	lb.	.40 /	.425
B-400	lb.	.25 /	.275
CC-55	lb.	.305 /	.33
DOP	lb.	.28 /	.305
R2H	lb.	.59	
TOF	lb.	.43 /	.455
Flexricin 66	lb.	.3275	
P-4		.30	
P-6	lb.	.37	
P-8	lb.	.32	
Good-Rite GP-233, -235, -236	lb.	.40 /	.435
GP-261	lb.	.285 /	.32
GP-265	lb.	.29 /	.325
GP-266	lb.	.295 /	.33
Harflex 10	lb.	1.30 /	1.39
40	lb.	.665 /	.755
50	lb.	.60 /	.69
60	lb.	.65 /	.74
90	lb.	.92 /	1.01
120, 150	lb.	.28 /	.375
140, 160	lb.	.30 /	.395
180	lb.	.27 /	.36
220, 250, 260	lb.	.40 /	.495
300	lb.	.58 /	.675
325	lb.	.4325/	.52
500	lb.	.315 /	.41
Harchem butyl stearate	lb.	.2375/	.3275
Sebacic acid, CP	lb.	.77 /	.89
Purified	lb.	.69 /	.81
Harshaw dibutyl phthalate	lb.	.325 /	.385
Kapsol	lb.	.33 /	.355
Kessoflex BCL	lb.	.365 /	.375
BCO	lb.	.355 /	.365
BCP	lb.	.33 /	.36
BCS	lb.	.305 /	.315
BO	lb.	.26 /	.28
BS	lb.	$0.235 /	$0.26
DBT	lb.	.64	
DDA, DIOA, DOA	lb.	.40 /	.435
DOZ	lb.	.46 /	.50
MCO	lb.	.3225/	.3525
MCP	lb.	.37 /	.40
MCS	lb.	.33 /	.34
ODA	lb.	.47 /	.50
TRA	lb.	.37 /	.40
KP-23	lb.	.29 /	.325
-90	lb.	.40 /	.435
-140	lb.	.46 /	.485
-201	lb.	.58 /	.59
-220	lb.	.32 /	.355
-555	lb.	.565 /	.57
Kronisol	lb.	.33 /	.365
Kronitex AA, I, K-3, MX	lb.	.325 /	.36
Methox	lb.	.385 /	.41
Monoplex DBS	lb.	.64 /	.665
DCP	lb.	.2925/	.32
DOS	lb.	.58 /	.605
S-38	lb.	.215 /	.24
S-70	lb.	.3925/	.42
S-71	lb.	.45 /	.475
Monsanto dibutyl phthalate	lb.	.30 /	.33
Diethyl phthalate	lb.	.25 /	.28
Dimethyl phthalate	lb.	.275 /	.305
Diphenyl phthalate	lb.	.5175/	.5375
DIDA, DOA	lb.	.425 /	.455
DIDP, DIOP, DOP	lb.	.305 /	.335
HB-20	lb.	.15 /	.17
HB-40	lb.	.22 /	.24
Orthonitrobiphenyl	lb.	.13 /	.15
Tricresyl phosphate	lb.	.325 /	.36
Triphenyl phosphate	lb.	.39 /	.40
Morflex P-50	lb.	.68 /	.71
Naugatuck decylbutyl phthalate	lb.	.27 /	.30
Dibutyl phthalate	lb.	.30 /	.33
Sebacate	lb.	.645 /	.67
Diisooctyl adipate, dioctyl adipate	lb.	.425 /	.455
Diisooctyl phthalate, dioctyl phthalate, Isooctyl decyl phthalate	lb.	.305 /	.335
Dinonyl adipate	lb.	.445 /	.475
Dioctyl sebacate	lb.	.585 /	.61
Epoxy plasticizer	lb.	.335 /	.36
Tricresyl phosphate	lb.	.345 /	.375
Ohio-Apex butyl oleate	lb.	.2325/	.265
Stearate	lb.	.22 /	.255
Diallyl phthalate	lb.	.49 /	.525
Dibutyl phthalate	lb.	.30 /	.335
Di-Carbitol phthalate	lb.	.40 /	.425
Diisobutyl adipate	lb.	.41 /	.445
Diisodecyl phthalate	lb.	.305 /	.34
Dioctyl phthalate	lb.	.305 /	.34
D.I.O.P.	lb.	.305 /	.34
Tributyl phosphate	lb.	.50 /	.535
Ohopex Q-10	lb.	.295 /	.33
R-9	lb.	.3525/	.3775
Paraplex 5-B	lb.	.29 /	.3475
AL-111	lb.	.32 /	.3275
G-20	lb.	.76 /	.7675
G-[illegible]	lb.	.76 /	.77
G-[illegible]	lb.	.4825/	.51
G-50	lb.	.39 /	.4175
G-53	lb.	.4325/	.46
G-60, -61	lb.	.3325/	.36
G-62	lb.	.3525/	.38
RG-2	lb.	.41 /	.6575
RG-7	lb.	.33 /	.335
RG-8	lb.	.505 /	.5125
RG-10	lb.	.52 /	.5275
Pfizer acetyl tributyl citrate, tech	lb.	.32 /	.57
Acetyl triethyl citrate, tech.	lb.	.36 /	.57
Triethyl citrate	lb.	.4575/	.58
Plasticizer 1	lb.	1.17 /	1.37
Plasticizer 120	lb.	.44 /	.49
Plastoflex #3	lb.	.52 /	.57
#520	lb.	.36 /	.435
DBE	lb.	.50 /	.55
MGB	lb.	.29 /	.37
VS	lb.	.3575/	.3975
Plastolein 9050 DHZ	lb.	.52 /	.56
9055 DGP	lb.	.28 /	.32
9057 DIOZ	lb.	.455 /	.50
9058 DOZ	lb.	.455 /	.50
9078LT	lb.	.40 /	.445
9250 THFO	lb.	.3575/	.4025
9404 TGP	lb.	.3725/	.4175
9715 & 9720 Polymeric	lb.	.365 /	.41
Polycizer 162, 562, 662	lb.	.285 /	.445
332, 532, 632	lb.	.40 /	.555
Polycon #7, 9, 10, 11	lb.	.305 /	.335
#30	lb.	.30 /	.33
#31	lb.	.27 /	.30
#40	lb.	.245 /	.275
PX-104	lb.	.30 /	.33
-108, -118, -120, -138	lb.	.305 /	.335
-114	lb.	.27 /	.30
-208, -220, -238	lb.	.425 /	.455
-404	lb.	.645 /	.67
-438	lb.	.585 /	.61
-800	lb.	.325 /	.35
-917	lb.	.33 /	.36
Pycal 40	lb.	.3875/	.4375
60	lb.	.60 /	.635
62	lb.	.80 /	.835
94	lb.	.3275/	.3775
140	lb.	.35 /	.40
170	lb.	.275 /	.325
194	lb.	.2775/	.3275
RC Plasticizers: B-17	lb.	.21 /	.245

BD-8	lb.	$0.38 /	$0.4125
BIDP	lb.	.27 /	.305
DIDA, DIOA, DOA, ODA	lb.	.40 /	.435
DIDP	lb.	.29 /	.325
DIOP, DOP	lb.	.28 /	.315
DIOS, DOS	lb.	.60 /	.63
O-16	lb.	.275 /	.3075
ODP	lb.	.285 /	.32
TG-8	lb.	.3125/	.3425
TG-9	lb.	.41 /	.4425
Santicizer 1-H	lb.	.50 /	.51
3	lb.	.46 /	.47
8	lb.	.43 /	.44
9	lb.	.39 /	.42
140	lb.	.325 /	.36
141	lb.	.34 /	.37
160	lb.	.25 /	.28
601	lb.	.32	
602	lb.	.305	
B-16	lb.	.4875/	.4975
E-15	lb.	.5075/	.5375
M-17	lb.	.4275/	.4575
Staflex AX	lb.	.43	
BR	lb.	.26 /	.29
CP	lb.	.28 /	.31
DBES, DOS	lb.	.61 /	.635
DIOA, ODA	lb.	.435 /	.465
DIOP, DOP, MP	lb.	.305 /	.335
DOZ	lb.	.48 /	.5075
IXA	lb.	.32 /	.35
KA	lb.	.36 /	.3875
KD	lb.	.44 /	.4675
Witcizer #100	lb.	.26 /	.27
#101	lb.	.31 /	.32
#200	lb.	.195 /	.205
#201	lb.	.235 /	.245
#300	lb.	.30 /	.33
#312, 313	lb.	.305 /	.33
#412	lb.	.435 /	.465

Resins & Molding Compounds

Acrylic

Cadco cast rods	lb.	1.42 /	6.96
Polished	lb.	1.58 /	7.16
Machined rods	ft.	22.00 /	39.54
Tubes	lb.	1.39 /	5.76
Polished	lb.	1.51 /	5.99
Colors	lb.	1.62 /	5.99
Pearl	lb.	1.99 /	6.76
Lucite injection molding powders:			
Colorless, transparent	lb.	.55	
Std. colors	lb.	.59 /	1.00
Stock colors	lb.	.59 /	.84
Granular Powders for compression & extrusion	lb.	.51 /	.75
Plexiglas molding powders:			
Colorless	lb.	.55 /	.30
Colors, stock	lb.	.59 /	.84
Custom	lb.	.59 /	1.00
Sheets, Types I-A & II			
Colorless	sq. ft.	.80 /	22.18
Colors	sq. ft.	.88 /	1.10
Type R, Colorless	sq. ft.	.60 /	12.64
Colors	sq. ft.	.69 /	1.07
Type RL, colorless	sq. ft.	1.27 /	1.50
Colors	sq. ft.	1.52 /	1.80
Polycast 1	sq. ft.	.80 /	2.40

Alkyd

Plaskon foundry resin 580-11L	lb.	.245 /	.275
Molding Compound,			
Type 411	lb.	.43 /	.60
Type 413, 417	lb.	.57 /	.74
Type 420 black	lb.	.44 /	.695
Type 422 colored	lb.	.51 /	.695
Mottle	lb.	.52 /	.705
Natural	lb.	.49 /	.60
Type 430	lb.	.34 /	.50

Cellulosic

Cellulose acetate:			
Celanese cast & extruded film:			
Standard length rolls, clear	lb.	.67 /	1.01
Colors	lb.	.93 /	1.19
Matte finish	lb.	1.43 /	1.77
Stock & cut sheets, clear	lb.	.033 /	.11
Colors	lb.	.044 /	.136
Matte finish	lb.	.087 /	.162
Celanese cast sheeting:			
Standard length rolls, clear	M. sq. in.	.129 /	1.47
Matte finish	M. sq. in.	.16 /	.657
Tinted	M. sq. in.	.243 /	.722
Stock & cut sheets, clear	M. sq. in.	.145 /	1.55
Matte finish	M. sq. in.	.183 /	.767
Tinted	M. sq. in.	.259 /	.862
Hercocel A, extrusion & injection	lb.	.50 /	.65
Injection, std. colors	lb.	.46 /	.61
Special colors	lb.	$0.42 /	$0.45
Lumarith molding compounds:			
Group I	lb.	.50 /	.59
Group II	lb.	.46 /	.55
Group III	lb.	.38 /	.48
Non-stock extruded rolls, clear	M. sq. in.	.13 /	1.28
Colors	M. sq. in.	.16 /	1.50
Extruded sheets, clear	M. sq. in.	.15 /	1.95
Colors	M. sq. in.	.17 /	2.13
Stock extruded rolls, clear	M. sq. in.	.13 /	.88
Colors	M. sq. in.	.16 /	.91
Extruded sheets, clear	M. sq. in.	.15 /	1.67
Colors	M. sq. in.	.17 /	1.67
Poly-Cell Group I	lb.	.50 /	.59
Group II	lb.	.46 /	.55
Group III	lb.	.38 /	.48
Group IV	lb.	.57 /	.66
Group V	lb.	.52 /	.61
Tenite Acetate, Group 1	lb.	.50 /	.59
Group 2	lb.	.46 /	.55
Group 3	lb.	.41 /	.51
Group 4	lb.	.38 /	.49
Group 5	lb.	.65 /	.75
Cellulose acetate butyrate:			
Tenite butyrate	lb.	.62 /	.71
A pearls	lb.	.72 /	.81
Blacks, reprocessed	lb.	.50 /	.58
Cellulose propionate:			
Forticel	lb.	.63 /	.71
Essence pearls	lb.	.73 /	.81
Reprocessed blacks	lb.	.51 /	.58
Ethyl cellulose:			
Dyeform 720, 721	lb.	1.29 /	1.52
Ethocel PG	lb.	.72 /	.80
Bulk, reg.	lb.	.66 /	.81
Std., 7 cps.	lb.	.71 /	.86
Hercocel E	lb.	.72 /	.88

Epoxy

Araldite 502, 506, 6005			
6010	lb.	.77 /	.86
6020, 6030, 6040	lb.	.80 /	.86
6060	lb.	.75 /	.83
6071, 6075	lb.	.615 /	.6225
6084	lb.	.595 /	.6025
6097	lb.	.6025/	.6125
6099	lb.	.69 /	.6975
Bakelite ERL Series	lb.	.80 /	.995
Epocast 2, 3, 5	lb.	1.33 /	1.77
4-B-2, 4-B, 4-C, 4-C-T, 4-D, Paste	lb.	1.09 /	1.15
Epon 562	lb.	1.52 /	1.77
815	lb.	.80 /	.99
820, 828	lb.	.80 /	.97
834	lb.	.855 /	1.00
864	lb.	.91 /	1.06
864-C-75	lb.	.73 /	.85
1001	lb.	.615 /	.85
1004	lb.	.595 /	.6025
1007	lb.	.605 /	.6125
1009	lb.	.69 /	.6975
Furane CN-502	lb.	1.33 /	1.77
Jet-Kote (with cat.)	gal	7.50 /	10.00
Maraset 602, 610, 610V, 612B 613, 648	lb.	1.2 /	1.70
604A, 607	lb.	1.1½ /	1.40
608	lb.	1.17 /	1.65
614A, 631A, 618A, 640	lb.	1.32 /	1.77
645	lb.	1.15 /	1.70
Reichhold Polytool Resins:			
6125, 6130, 6140	lb.	.80 /	1.58
Rezolin L-900, 900W	lb.	1.00 /	1.94
902	lb.	2.41	
906	lb.	1.19 /	1.80
910	lb.	1.086 /	2.34
916, 916A	lb.	1.19 /	1.71
940	lb.	1.285 /	2.29
930A	lb.	1.29 /	1.90
933A	lb.	1.29 /	1.80
953A	lb.	1.665 /	1.99
LT-904	lb.	.996 /	1.83
914	lb.	1.073 /	2.18
932	lb.	1.05 /	1.79
Toolplastik packages:			
L-900, L-930	lb.	1.59 /	2.29
L-902	lb.	1.69 /	1.84
L-904	lb.	1.54 /	2.19
L-910	lb.	1.94 /	2.34
L-914	lb.	1.83 /	2.19
L-931	lb.	1.75 /	1.99
L-940	lb.	2.05 /	2.29

Fluorocarbon

Bakelite FGBB-33789, FGEB-34790, FXMA-50590, FXMB-50344	lb.	9.00 /	10.00
FGEB-32788, FXMB-50090	lb.	12.00 /	14.00
FYTD	lb.	11.00 /	13.00
FYTH, FYTS	lb.	8.50 /	9.50
Kel-F Grade 270, 300			
High density	lb.	6.50 /	9.00
Low density	lb.	6.00 /	8.50
Grade 300—P-25			
High density	lb.	7.50 /	10.00
Low density	lb.	7.00 /	9.50
Grade 500-F, 500-R			
High density	lb.	7.00 /	9.50
Low density	lb.	6.50 /	9.00
Polyfluoron, high density pellets, grades HT, MT, LT	lb.	$6.50 /	$9.00
colored	lb.	7.00 /	9.50
Low density pellets, Clear grades HT, MT, LT	lb.	6.00 /	8.50
colored	lb.	6.50 /	9.00
Mikron-atomized powder, clear dispersion grades HT, MT, LT	lb.	8.00 /	10.50
colored	lb.	8.50 /	11.00
Liquid dispersions, 40% HT, MT, LT	lb.	4.20 /	4.40
35% HT, MT, LT	lb.	3.20 /	3.85
30% HT, MT, LT	lb.	3.15 /	3.30
25% HT, MT, LT	lb.	2.65 /	2.75
Teflon 1	lb.	4.50 /	5.55
5	lb.	4.75 /	5.80
6	lb.	7.45 /	8.00
30 aqueous dispersion	lb.	5.60 /	6.85

Melamines

Fiberite 2015 (black & pastels)	lb.	.57 /	.62
Pelleted	lb.	.61 /	.66
Cymel 402	lb.	.51 /	.53
404R, 404T	lb.	.85 /	.95
405	lb.	.45 /	.52
428	lb.	.48 /	.55
430	lb.	.465 /	.535
440	lb.	1.10	
480	lb.	.265 /	.315
1077, 1079	lb.	.45 /	.75
Ungranulated	lb.	.43 /	.73
1500	lb.	.42 /	.55
1502	lb.	.45 /	.58
3020	lb.	.57 /	.72
3024-A	lb.	.67	
3135	lb.	.85 /	1.05
3136	lb.	1.05 /	1.15
P-592, -592-A	lb.	.65 /	.75
Plaskon	lb.	.44 /	.75

Phenolic

91-LD	lb.	1.50 /	2.50
Admires PL-50	lb.	.215	
UP-11	lb.	.2325	
Bakelite general purpose	lb.	.187 /	.3525
BMG-5000	lb.	.19 /	.30
Colors	lb.	.2375/	.435
Chem. resist.	lb.	.23 /	.40
Electrical Insul.	lb.	.2725/	.4125
Heat resist.	lb.	.19 /	.35
Impact resist.	lb.	.24 /	.4025
Barrett foundry resins, liquid	lb.	.2125/	.2425
Powdered	lb.	.27 /	.355
Insulation resins	lb.	.15 /	.175
Molding resin 313, 314, 317	lb.	.27 /	.285
316	lb.	.295 /	.31
1502, -3, -4, -5, R-110R	lb.	.25 /	.265
R-114	lb.	.285 /	.30
Corfoam 107, 114	lb.	.55 /	.82
Cyacor 151	lb.	.215 /	.235
191	lb.	.13 /	.16
Durez, Brake lining resins:			
8054, powdered	lb.	.35 /	.39
13848, powdered	lb.	.29 /	.33
14000, powdered	lb.	.32 /	.36
Foundry resins:			
18115, liquid	lb.	.22 /	.23
18123, 18250, powdered	lb.	.265 /	.275
Resins, rubber compounding:			
12603, lump	lb.	.245 /	.255
12687, powdered	lb.	.36 /	.40
13355, powdered	lb.	.275 /	.315
Resins, wood flour bonding:			
12763, 18520, powdered	lb.	.30 /	.31
Durite GP	lb.	.195 /	.24
HR	lb.	.191 /	.3025
IM	lb.	.24 /	.415
SG	lb.	.195 /	.3575
Dyform	lb.	1.10 /	1.35
Fiberite 1078	lb.	.42 /	.43
1087, 1165, 1270, 1271, 1330, 1332, 1347, FM 1132, FM 3510	lb.	.39 /	.395
1153	lb.	.455 /	.46
1167	lb.	.3875/	.3925
1340	lb.	.4275/	.4325
1346	lb.	.44 /	.4475
4010	lb.	.68	
4020	lb.	.815 /	.82
FM 926	lb.	.43 /	.435
927	lb.	.41 /	.415
1914	lb.	.375 /	.38
1957	lb.	.445 /	.45
1996	lb.	.375 /	.38
10365	lb.	.5225/	.5275
11547	lb.	1.05 /	1.06
11678	lb.	.52 /	.525
14111	lb.	.415 /	.42
17067	lb.	.851 /	.82
17610	lb.	1.05 /	1.06

Fiberite 1078	lb.	$0.425 / $0.435
1087, 1165, 1270, 1271, 1330, 1332, 1347, 1389, FM-1132, FM-3510, FM-3515	lb.	.395 / .40
1153 (red only)	lb.	.46 / .465
1167	lb.	.3925/ .3975
1333, FM-10365, FM-11678	lb.	.67 / .675
1346, FM-927	lb.	.415 / .42
1346 (red only)	lb.	.445 / .452
4030-190	lb.	.78 / .81
4031	lb.	.625 / .63
FM-926	lb.	.435 / .44
FM-1132 (pellets), FM-14111	lb.	.42 / .425
FM-1914, FM-1996	lb.	.38 / .385
FM-11547, FM-17610	lb.	1.07 / 1.08
FM-11679	lb.	1.29 / 1.30
FM-17067	lb.	.83 / .835
G-E molding powders:		
12401	lb.	.31 / .41
13408, 12486	lb.	.205 / .215
12410, 12420	lb.	1.50 / 1.60
12432	lb.	.405 / .505
12433	lb.	.565 / .665
12435	lb.	.25 / .35
12439-A, 12466	lb.	.265 / .365
12444	lb.	.435 / .535
12463	lb.	.415 / .515
12467	lb.	.51 / .61
12487, 12489, 12884, 12887	lb.	.365 / .465
12491, 12493, 12853, 12900, 12901, 12902, 12920, 12921	lb.	.21 / .31
12494	lb.	.385 / .485
12808	lb.	.50 / .60
12809	lb.	.66 / .76
12871-A	lb.	.22 / .32
12824	lb.	.505 / .605
12841, 12906	lb.	.255 / .355
Loven LHR-401, -403	lb.	.225 / .23
-407, -409	lb.	.60 / 1.00
-408	lb.	.25 / .255
LI-201	lb.	.39 / .40
-207	lb.	.475 / .48
-209	lb.	.60 / 1.00
LI-212	lb.	.425 / .43
LM-110, -119	lb.	.19 / .195
-101	lb.	.24 / .245
-116	lb.	.255 / .26
-117	lb.	.225 / .23
-118	lb.	.1975/ .2025
LMI-301	lb.	.2525/ .2575
-303	lb.	.345 / .35
-304	lb.	.60 / 1.00
-307	lb.	.3075/ .3125
LMM-801, -803	lb.	.2125/ .2175
-804, -811	lb.	.245 / .25
-807	lb.	.215 / .22
Marblette 76, 77	lb.	.50 / .60
Foam resin 1076	lb.	.50 / .60
Plenco foundry resins	lb.	.27 / .35
Molding cmpds. gen. purpose	lb.	.185 / .235
Heat resist	lb.	.19 / .24
Improved impact	lb.	.225 / .28
Min. bleed	lb.	.185 / .195
Radio & TV	lb.	.20 / .215
Stock	lb.	.205 / .34
Reichhold Foundry Resins:		
Corciment	lb.	.135 / .17
Corovit	lb.	.275 / .31
Foundrez, core binder liquids	lb.	.21 / .25
Shell molding liquids	lb.	.195 / .245
Powders	lb.	.2675/ .3025
Plyophen molding cmpds.:		
5440, 5596, 5655, 5660	lb.	.30 / .325
5510, 5510-C	lb.	.34 / .365
5657, 5658, 5661	lb.	.315 / .34
Reilly general purpose	lb.	.195 / .20
Heat & impact resist	lb.	.20 / .205
Resinox molding compounds:		
Gen. purpose & heat resist	lb.	.205 / .215
Impact	lb.	.255 / .3225
Low elec. loss	lb.	.31 / .365
Special grade	lb.	.213 / .255
Rogers phenolic molding compounds:		
RX 425	lb.	.29 / .295
Special colors	lb.	.34 / .405
RX 428	lb.	.355 / .36
Special colors	lb.	.42 / .465
RX 429	lb.	.365 / .37
Special colors	lb.	.395 / .48
RX 431	lb.	.4125/ .4175
Special colors	lb.	.455 / .55
RX 438	lb.	.4675/ .4725
RX 441, 455	lb.	.32 / .325
RX 442	lb.	.3475/ .3525
RX 447	lb.	.5025/ .51
RX 448	lb.	.355 / .36
RX 458	lb.	.38 / .385
RX 469	lb.	.365 / .37
RX 470, 480	lb.	.40 / .405
RX 478, 488	lb.	.415 / .43
RX 525, 545	lb.	.29 / .295
RX 530	lb.	.4125/ .4175
Special colors	lb.	.42 / .475
RX 547	lb.	.37 0 .375
RX 625	lb.	.395 / .40
RX 628	lb.	.455 / .46
Schenectady shell mold resins	lb.	.26 / .28
Synvar molding compounds, PM series	lb.	$0.205 / $0.2625
Synvaren 640	lb.	.30 / .335
920	lb.	.21 / .245
935	lb.	.195 / .23
9203, 9203A	lb.	.173 / .208
Synvaren liquid industrial resins:		
675	lb.	.29 / .325
920	lb.	.21 / .245
CP-66	lb.	.19 / .225
PBL-2	lb.	.33 / .365
PBL-218S	lb.	.27 / .305
Synvarite GW-1000	lb.	.34 / .36
GW-1080, PBL-F, PBL-718	lb.	.37 / .39
GW-2400	lb.	.375 / .395
PBL-100	lb.	.31 / .33
PBL-108FF	lb.	.38 / .40
PBL-210, PBL-3301	lb.	.36 / .38
PBL-410	lb.	.33 / .35
PBL-3311	lb.	.35 / .37
PNL-12HL/11, PNL-156HL/24	lb.	.3025/ .3225
PNL-159H, PNL-169H	lb.	.29 / .31
PNL-169PD, PNL-179PD	lb.	.28 / .30
PNL-355PD	lb.	.315 / .335
PNL-1279HL	lb.	.2875/ .3075
PT	lb.	.32 / .34
Teolplastik No. 8000	lb.	.48 / .72

Polyamide

Fiberfil Nylon G, natural	lb.	1.70 / 1.90
Standard colors	lb.	1.80 / 2.20
Nylatron G, GS	lb.	1.75 / 2.00
Plaskon 8200, 8201 natural	lb.	1.33 / 1.50
Black	lb.	1.53 / 1.70
White	lb.	1.43 / 1.60
Other colors	lb.	1.63 / 1.80
Spencer Nylon 400, 401, 402	lb.	1.33 / 1.50
60, 602	lb.	1.48 / 1.65
601	lb.	1.95 / 2.10
603, 604	lb.	1.83 / 2.00
Versamid 115	lb.	.64 / .82
Zytel molding powder	lb.	1.435 / 1.60
Zytel, natural color	lb.	1.18 / 1.35
Blacks and whites	lb.	1.43 / 1.80
Colors	lb.	1.63 / 2.05

Polyesters

Acme 1-501	lb.	.82 / .93
1-501A	lb.	.87 / .98
1-503	lb.	2.75 / 3.50
1-510	lb.	.89 / 1.00
Atlac 363E-02Z, -12Z	lb.	.66 / .69
-32Z	lb.	.68 / .71
382E	lb.	.57 / .60
FP	lb.	.66 / .69
Bakelite Polyester resins	lb.	.35 / .75
Diall 50-01	lb.	2.45
50-51	lb.	3.25 / 3.50
50-52	lb.	3.50
51-01	lb.	.87 / 1.15
52-01	lb.	2.25 / 2.50
52-20-30	lb.	1.50
Diall 50-01, 50-51, 50-52	lb.	2.75 / 3.50
51-01	lb.	.87 / .98
52-01	lb.	1.95 / 2.50
52-20-30	lb.	1.30 / 1.50
Fibercore 1000, 2000	lb.	.50 / .65
3000	lb.	.55 / .70
G-E polyesters		
AR 401	lb.	.35 / .365
AR 403, 480	lb.	.34 / .355
AR 403 LS, 480 LS	lb.	.355 / .37
AR 493	lb.	.40 / .415
AR 499	lb.	.435 / .45
AR 501	lb.	.455 / .47
Hetron 33	lb.	.39 / .405
32A	lb.	.435 / .45
92	lb.	.43 / .445
93LS	lb.	.485 / .50
IC-312, -400, -514, -548, -625, -730, -800	lb.	.35 / .385
-312-2	lb.	.365 / .38
-336, -382, -706	lb.	.37 / .385
-401	lb.	.44 / .455
-420	lb.	.355 / .37
-433	lb.	.38 / .395
-636, -670	lb.	.48 / .495
-638, -689	lb.	.55 / .565
-670-2	lb.	.50 / .515
-671	lb.	.405 / .42
Filled resins	lb.	.255 / .54
Laminac 4110	lb.	.33 / .345
4111	lb.	.45 / .465
4116	lb.	.33 / .345
4120	lb.	.39 / .405
4123, 4128	lb.	.34 / .355
4134	lb.	.46 / .475
4146	lb.	.43 / .445
4192	lb.	.355 / .37
4202	lb.	.55 / .565
Marco resins:		
CEL-101, Marcothix 1, 3	lb.	$0.50 / $0.515
Marcothix 5, 7, 8	lb.	.46 / .475
Marcothix 9, MR-31C, -31V	lb.	.37 / .385
Marcothix 10, MR-28C, -28V, -37C, -37CX	lb.	.33 / .345
MR-28CS	lb.	.35 / .365
MR-28H, -41R	lb.	.36 / .375
MR-28R,-42R	lb.	.34 / .355
MR-28RL, -37RL	lb.	.355 / .37
MR-30C	lb.	.44 / .455
MR-33C	lb.	.53 / .545
MR-40R	lb.	.38 / .395
MR-60C	lb.	.41 / .425
MR-61H	lb.	.42 / .435
Mylar, rolls, types A & C	lb.	2.50 / 4.80
Type D	lb.	3.00 / 3.30
Sheets, type A	M. sq. in.	.09 / 1.11
Type C	M. sq. in.	.09 / .15
Type D	M. sq. in.	.53 / 1.34
Plaskon 911, 920	lb.	.55 / .665
941, 942, 951, 9411	lb.	.35 / .465
943	lb.	.41 / .525
9404	lb.	.365 / .4b
9406	lb.	.355 / .465
9500, 9510, 9511	lb.	.35 / .465
9600	lb.	.44 / .555
Pleogen 1000, 1001, 1002, 1006, 1007, 1100, 1810	lb.	.34 / .355
1150, 1501	lb.	.365 / .375
1201	lb.	.50 / .51
1300, 1301	lb.	.35 / .36
1300LS, 1700, 1813	lb.	.37 / .38
1402	lb.	.44 / .45
1406	lb.	.46 / .47
1602	lb.	.35 / .365
1800, 1802	lb.	.45 / .46
Polycast 2	sq. ft.	1.89 / 5.18
3	sq. ft.	1.08 / 18.00
6	sq. ft.	.66 / 3.10
7	sq. ft.	.72 / 7.18
CR-39	sq. ft.	1.25 / 20.00
Polylite 8000, 8001, 8005, 8007, 8017, 8037, 8173, 8200	lb.	.34 / .355
8006, 8008, 8009, 8039, 8166	lb.	.35 / .365
8016, 8100	lb.	.365 / .38
8050	lb.	.41 / .425
8061, 8065	lb.	.44 / .455
8120	lb.	.48 / .495
8150	lb.	.45 / .465
8170, 8237	lb.	.38 / .395
8180, 8181	lb.	.36 / .375
8400	lb.	.56 / .575
Pre-Imp	lb.	.68 / .85
Thermaflow 100, 200, 300	lb.	.48 / .82
400, 500	lb.	.52 / .87
1,000, 2,300	lb.	.34 / .55
2,400	lb.	.36 / .58
Vibrin 114, 117, 152, 154	lb.	.34
115A	lb.	.38
121	lb.	.46
135	lb.	3.00
142	lb.	.50
151	lb.	.35
152LS-4	lb.	.355
153	lb.	.40
X-1633-A	lb.	.49
X-1636-W	lb.	.585

Polyethylene

A-C No. 6, 617	lb.	.30 / .37
No. 6A, 7, 617A	lb.	.35 / .42
No. 615, G-201	lb.	.38 / .45
No. 629	lb.	.40 / .47
No. 729	lb.	.45 / .52
Alathons, Group I	lb.	.35 / .43
Group II	lb.	.37 / .515
Group III	lb.	.375 / .42
Bakelite DE Series	lb.	.43 / .725
DYGT	lb.	.54 / .69
DYLT, DYNF, DYNH	lb.	.41 / .59
DYNJ	lb.	.44 / .62
DYNK	lb.	.45 / .63
Catalin 15-5	lb.	.41 / .59
Marlex 50, natural	lb.	.47 / .50
plain	lb.	.53 / 1.10
black	lb.	.495 / .575
Petrothene 100, 101, 200, 202, 203, 205, 206, 207, 208, 301	lb.	.35 / .45
300, 300-200	lb.	.465 / .565
300-6	lb.	.425 / .525
301, electrical grade	lb.	.41 / .51
301-6	lb.	.37 / .47
301-200, 301-202, 302-506, 560	lb.	.375 / .48
302-6	lb.	.39 / .49
Poly-Eth 1007, 1008.5, 1408.5, 2007, 2206, 2215, 2235, 2236, 2256, 2405, 2425, 2455	lb.	.35 / .49
Hi-D 1504, 1506, 2504	lb.	.42 / .56
3215, 5005	lb.	.375 / .515
3405	lb.	.38 / .52
4005, 4225	lb.	.41 / .55
4202, 5003, 5202	lb.	.51 / .66

Reynolon 1000, P series	lb.	$0.60	$0.80
Rulan 2	lb.	.48	.52
Tenite Group 1	lb.	.41	.45
Group 2	lb.	.43	.47
Group 3	lb.	.46	.50
Group 4	lb.	.39	.43
Group 5, 6	lb.	.50	.72
Group 7	lb.	.60	.82
Group 8	lb.	.70	.92

Silicone

Bakelite GMGA-5001, -5002	lb.	2.75	3.10
5003	lb.	4.00	4.35
5004	lb.	5.40	5.75
Dow Corning 301	lb.	3.60	4.00
2103	lb.	1.55	1.65
2105, 2106	lb.	1.59	1.70

Styrenes

Ampacet, crystal	lb.	.315	.335
Colors, std.	lb.	.345	.365
Special	lb.	.345	.75
Pearl	lb.	.41	.75
Phosphorescent	lb.	.695	1.00
Tinsel	lb.	.41	.67
Confetti	lb.	.51	.70
Bakelite BMC series, nat.	lb.	.45	.685
Colors	lb.	.50	.735
BMS, SMD series, crystal	lb.	.295	.31
Colors, std.	lb.	.335	.35
Special	lb.	.335	.52
RMD series, nat.	lb.	.45	.685
Colors	lb.	.50	.735
TGD series	lb.	.33	.35
Colors, std.	lb.	.36	.38
Special	lb.	.36	1.00
TMD series	lb.	.33	.40
Colors, std.	lb.	.36	.43
Special	lb.	.36	1.00
Catalin, high impact, natural	lb.	.325	.355
Colors, std	lb.	.355	.385
Special	lb.	.36	1.00
Medium impact, natural	lb.	.325	.355
Colors, std.	lb.	.355	.385
Special	lb.	.355	1.00
Regular grade, crystal	lb.	.305	.325
Colors, std.	lb.	.345	.365
Special	lb.	.345	1.00
Utility black	lb.	.18	.235
Cycolac compounds:			
Natural powders	lb.	.53	.65
Natural & std. color pellets	lb.	.58	.62
Darex Copolymer 3	lb.	.47	.67
43G	lb.	.39	.58
X34	lb.	.42	.61
Latices 3L	lb.	.415	.56
610L	lb.	.30	.46
3020	lb.	.32	.47
Dow Latex: styrene/butadiene	lb.	.295	.57
Resins PS-2&3	lb.	.25	.35
butadiene	lb.	.30	.46
Dylite, expandable beads	lb.	.50	.60
Fiberfil Styrene G, natural	lb.	.55	1.00
Standard colors	lb.	.65	2.00
Koppers, Fibertuff	lb.	.55	1.505
MC-185 series	lb.	.33	.355
-300 series	lb.	.33	1.005
-400 series	lb.	.355	1.005
Regular, crystal	lb.	.295	.315
Colors, std.	lb.	.335	.355
Special	lb.	.335	1.005
Pearl	lb.	.41	1.005
Phosphorescent	lb.	.695	2.005
Kralastic, std. colors	lb.	.50	1.10
Lustrex Hi-Flows 55, 66, 77, and Hi-Heat 99 crystals	lb.	.26	.275
LHA standard colors	lb.	.34	.365
special colors	lb.	.34	1.00
Hi-Test 88 & 89	lb.		
Natural & 844 black	lb.	.32	.34
standard colors	lb.	.345	.385
special colors	lb.	.345	1.00
Marbon resins	lb.	.39	.46
Plio-Tuf C75, R100	lb.	.37	.45
G85	lb.	.52	.59
P100, std. colors	lb.	.41	.45
Polycast 4	sq. ft.	2.56	11.07
Styron 475, natural	lb.	.33	.35
Colors, std.	lb.	.36	.38
Special	lb.	.36	1.00
Sheets, std.	lb.	.55	.60
Special	lb.	.55	.62
480, natural black	lb.	.38	.40
Colors, std.	lb.	.41	.43
Special	lb.	.41	1.00
647, crystal	lb.	.305	.32
Colors, special	lb.	.345	1.34
66, 688, crystal	lb.	.295	.31
Colors, std.	lb.	.335	.35
Special	lb.	.335	1.00
700, crystal	lb.	.295	.31
Colors, std.	lb.	.335	.35
Special	lb.	.335	1.00
777 colors, std.	lb.	.355	.375
Special	lb.	.355	1.00

Urea

Admirez Foundry Resins, SP-30	lb.	$0.27	
UP-50	lb.	.105	
Beetle C-4980 Brown	lb.	.1875/	.30
No fines granulation	lb.	.2075/	.32
T-298 Black	lb.	.1875/	.30
MUP series, powder	lb.	.30	.49
Special colors	lb.	.30	.59
Granules	lb.	.33	.52
Special colors	lb.	.33	.62
Foundrez core binder	lb.	.105	.14
Plaskon molding cmpds.:			
Black & Brown	lb.	.1875/	.30
Other colors	lb.	.30	.62
Foundry resins, liquid	lb.	.10	.13
Powdered	lb.	.2325/	.2525
Sylplast molding cmpds., granules	lb.	.33	
Powder	lb.	.30	

Vinyls

Bakelite QG-5909	lb.	.35	.585
QG-5921	lb.	.41	.645
5924	lb.	.43	.665
QYNA, QYSM, QYSQ	lb.	.27	.47
QYNV	lb.	.30	.50
QYSJ	lb.	.28	.48
VG-1914, 1918	lb.	.37	.056
1985	lb.	.35	.585
5507	lb.	.31	.545
5544	lb.	.405	.64
5911	lb.	.315	.55
5980	lb.	.32	.555
7734	lb.	.28	.515
9031	lb.	.265	.50
9530	lb.	.275	.51
9960, 9970, 9980	lb.	.335	.57
VAGH	lb.	.55	.75
VMCH	lb.	.41	.61
VYDR, VYNW	lb.	.27	.47
VYHH	lb.	.32	.52
VYLF	lb.	.36	.56
VYNS	lb.	.44	.64
VYNV	lb.	.32	.52
Blacar No. BW-60	lb.	.315	.385
NEMA colors	lb.	.355	.425
No. BW-80	lb.	.405	.455
NEMA colors	lb.	.445	.495
No. PC white, ivory, black	lb.	.285	.335
Other colors	lb.	.325	.375
Darex Everplex A (wet wt.)	lb.	.21	.39
B (wet wt.)	lb.	.22	.40
G (wet wt.)	lb.	.21	.39
Copolymer Y (wet wt.)	lb.	.245	.28
PVA Emulsions (wet wt.)	lb.	.19	.358
Diamond PVC-45, -50	lb.	.27	.33
Dow PVC-100, -111	lb.	.38	.57
Escambia 1200, 1225, 1250	lb.	.27	.47
Exon 402A, 500, 905, 915, 925	lb.	.27	.47
450, 468, 480	lb.	.32	.52
461	lb.	9.75	
470	lb.	.48	.68
471	lb.	.45	.65
481	lb.	.39	.59
485	lb.	.37	.57
654	lb.	.30	.50
Formvar	lb.	.865	1.03
Gelva emulsions	lb.	.19	.205
Granules	lb.	.4175/	.617
Geon 101, 101EP, 103EP, 202	lb.	.27	.45
121	lb.	.30	.48
126	lb.	.28	.46
400X110	lb.	.41	.59
404HI	lb.	.37	.55
409, 426, 427, 428	lb.	.32	.50
503H (polyblend)	lb.	.425	.525
2042, 2046	lb.	.315	.55
Colors	lb.	.365	.60
6373	lb.	.345	.58
Colors	lb.	.395	.63
6461	lb.	.325	.56
Colors	lb.	.375	.61
8372	lb.	.33	.565
Colors	lb.	.38	.615
8539, 8726	lb.	.33	.565
Colors	lb.	.35	.585
8590, 8591, 8592, 8593, 8594, 8595	lb.	2.00	2.75
8600	lb.	.275	.51
Colors	lb.	.325	.56
8620	lb.	.27	.505
Colors	lb.	.32	.555
8630	lb.	.425	.66
Colors	lb.	.475	.71
8640	lb.	.35	.585
8650	lb.	.32	.555
8677	lb.	.435	.67
8700A, 8750	lb.	.425	.66
Colors	lb.	.455	.69
8720	lb.	.605	.84
8737	lb.	.33	.565
8740	lb.	.295	.53
8749	lb.	.29	.525
8800	lb.	.44	.675
8801	lb.	.275	.51
Colors	lb.	.325	.56
8802	lb.	.33	.565
Colors	lb.	.38	.615
8804	lb.	.29	.525
8807	lb.	$0.45	$0.685
8809	lb.	.37	.605
8810	lb.	.275	.55
8812, 8813, 8814, 8815	lb.	.315	.51
Geon Latex 151, 251	lb.	.26	.32
351	lb.	.32	.38
352	lb.	.28	.34
552, 652	lb.	.37	.43
450x167	lb.	.39	.45
576	lb.	.365	.40
Krene, film	lb.	.505	.655
Sheeting	lb.	.49	.645
Marvinols:			
NF-1005	lb.	.34	.625
NF-1055, 3520	lb.	.275	.56
NF-3020	lb.	.41	.645
NF-3025	lb.	.38	.665
NF-3040	lb.	.3375/	.6225
NF-3045, 3050	lb.	.37	.605
NF-3055	lb.	.285	.57
NF-3060	lb.	.29	.575
NF-3065	lb.	.30	.585
NF-3070, 3075, 3080		.265	.50
NF-3085, 3090, 3095	lb.	.29	.525
NF-3505, 3515	lb.	.36	.595
NF-3510	lb.	.34	.575
NF-4005	lb.	.44	.675
NF-4010, 4015, 4020	lb.	.42	.705
NF-5015, 5020	lb.	.40	.655
NF-5025	lb.	.33	.585
NF-5030	lb.	.29	.545
NR-6015	lb.	.39	.685
NR-6020	lb.	.39	.675
NR-7002, 7045, 7060	lb.	.50	.735
VR-10	lb.	.28	.47
VR-12, -20, -21, -22, -24, -30	lb.	.27	.46
VR-50	lb.	.30	.49
Opalon 410	lb.	.30	.50
505, 510	lb.	.32	.52
1006	lb.	.315	.55
1018	lb.	.28	.515
1028, 1038, 72217, 75167, 75223	lb.	.33	.565
1308	lb.	.27	.505
1406	lb.	.415	.465
1706	lb.	.385	.62
71329	lb.	.275	.51
72285	lb.	.3375/	.5725
75179	lb.	.335	.57
78096	lb.	.395	.63
78197	lb.	.32	.55
78207	lb.	.29	.525
78210, 78211	lb.	.335	.57
78216	lb.	.31	.545
78343	lb.	.285	.52
Plastiflex, std.	lb.	.90	1.10
Novelty	lb.	1.15	1.50
Pliovic AO (dispersion)	lb.	.30	.32
DB80V, DB90V, EDB90V	lb.	.27	.29
Latex 300	lb.	.30	.35
Reynolon, 4000 series	lb.	1.55	2.30
Rolls, 1-mil	sq. yd.	.0625/	.11
Colors	sq. yd.	.0675/	.08
4-mil	sq. yd.	.215	.3125
Colors	sq. yd.	.2375/	.255
16-mil	sq. yd.	.81	1.19
Colors	sq. yd.	.86	.945
Satinflex	lb.	1.15	1.30
Vygen 110, 120	lb.	.27	.31
1101, 1150	lb.	.425	.50
2201	lb.	.48	.55

Vinylidine

Dow Latex 744-B	lb.	.26	.42
Resin 565	lb.	.39	.525
Saran formulation 115, black, nat.	lb.	.39	.52
Colors	lb.	.44	.69
720 nat.	lb.	.41	.54
Colors	lb.	.46	.71
747 nat.	lb.	.395	.525
761 nat.	lb.	.39	.52
Colors	lb.	.44	.69
820 nat.	lb.	.42	.55
Colors	lb.	.47	.6C
Latices	lb.	.45	.61
Resin F 120	lb.	.58	.65
F242	lb.	.64	.70

Solvents

Enjay acetone	lb.	.085	.12
Ethyl ester	gal.	.44	
Isopropyl acetate	lb.	.115	.15
Isopropyl alcohol 91%	gal.	.37	.60
95%	gal.	.39	.62
Anhydrous	gal.	.41	.64
Isopropyl ether	gal.	.30	.51
Methyl ethyl ketone	lb.	.125	.16
Secondary butyl acetate	lb.	.1225/	.1575
Secondary butyl alcohol	lb.	.125	.16

Stabilizers

Advastab B-13-P, BC-105, BC-147	lb.	.75	.80
BC-12, C-77, C-79, E-82	lb.	.90	.95
BC-74, BC-30	lb.	.70	.75
BZ-51, L paste, Z-6, Z-15	lb.	.65	.70

BZ-155	lb.	$0.69 /	$0.74
C-21	lb.	1.00 /	1.05
CH-101, CH-201	lb.	.60 /	.65
CZ-11	lb.	.95 /	1.00
E-98	lb.	.53 /	.58
JCX	lb.	.62 /	.67
SN	lb.	.47 /	.52
T-10, T-52	lb.	1.90 /	1.95
T-17M	lb.	2.95 /	3.00
T-50LT	lb.	3.20 /	3.25
T-52N	lb.	1.80 /	1.85
T-72, T-671	lb.	2.65 /	2.70
gus Mark C	lb.	.88 /	.95
E	lb.	.72 /	.85
M	lb.	.68 /	.74
PL	lb.	.63 /	.69
TT	lb.	.72 /	.86
WS	lb.	.98 /	1.11
X	lb.	2.50 /	2.75
XI	lb.	.87 /	1.01
XV	lb.	.92 /	.99
XX	lb.	.58 /	.65
Barca 10	lb.	.75 /	.80
Baker barium ricinoleate	lb.	.70	
Calcium ricinoleate	lb.	.55	
Zinc ricinoleate	lb.	.60	
Dutch Boy Barinac	lb.	.70	
Calstar	lb.	.37	
Clarite A	lb.	.83	
B	lb.	.68	
CS-137	lb.	1.25	
DS-207	lb.	.55	
Dyphos	lb.	.58 /	.595
50A	lb.	.34	
Dythal	lb.	.395 /	.41
Leadstar	lb.	.39	
Lectro 60	lb.	.2525	
Normal lead maleate	lb.	.4475	
Normasal	lb.	.46	
Pearlescent pigment	lb.	1.00	
Plumb-O-Sil-A	lb.	.3075	
-B	lb.	.325 /	.37
-C	lb.	.3475/	.375
Provinite A	lb.	.83	
B	lb.	.68	
Tribase	lb.	.275	
-E	lb.	.2225	
Trimal	lb.	.435	
Ferro 182	lb.	.70 /	.76
200	lb.	1.31 /	1.43
203, 900, 1820	lb.	.88 /	1.00
503	lb.	$0.28 /	$0.40
541A	lb.	.80 /	.92
700	lb.	.47 /	.59
703, 1972	lb.	.63 /	.75
823	lb.	2.50 /	2.75
840	lb.	3.25	
903	lb.	.58 /	.70
909	lb.	.91 /	1.01
1203	lb.	1.30 /	1.40
1206	lb.	1.23 /	1.33
1212	lb.	.68 /	.80
1825	lb.	.98 /	1.10
1840	lb.	.73 /	.85
1976	lb.	.45 /	.57
Harshaw 1-V-3	lb.	.43 /	.45
1-V-4	lb.	.665 /	.70
1-V-7, 1-V-26	lb.	.66 /	.68
2-V-4	lb.	.85 /	.87
2-V-5	lb.	1.09 /	1.12
5-V-1	lb.	.41 /	.43
7-V-2	lb.	.93 /	.95
8-V-1	lb.	.88 /	.90
8-V-21	lb.	.63 /	.65
8-V-100, 10-V-442	lb.	.82 /	.84
9-V-1	lb.	.70 /	.72
12-V-5	lb.	.73 /	.75
12-V-6	lb.	.92 /	.94
12-V-63	lb.	.72 /	.74
12-V-64	lb.	.68 /	.70
19-V-1	lb.	.52 /	.54
24-V-1	lb.	1.10 /	1.12
128-V-5	lb.	.86 /	.88
Merix AST Concentrate 1001	lb.	.355 /	1.73
Metasap 613-A	lb.	.69	
613-B	lb.	.84	
613-C	lb.	1.06	
621	lb.	.88	
624	lb.	.75	
Cadmium stearate	lb.	1.40 /	1.44
Fused stearates, calcium 602-A	lb.	.25 /	.30
Dibasic lead stearate	lb.	.56	
Lead 611	lb.	.32 /	.37
Lead stearate	lb.	.39 /	.44
Nuostable V-1	lb.	.54 /	.59
V-2	lb.	.39 /	.44
V-10	lb.	.70 /	.75
V-20	lb.	1.30 /	1.35
V-21	lb.	1.29 /	1.34
V-30	lb.	.90 /	.95
V-31	lb.	.80 /	.85
V-40	lb.	$1.18 /	$1.23
V-42	lb.	.65 /	.70
V-43	lb.	.75 /	.80
V-44	lb.	.90 /	.95
V-45	lb.	1.10 /	1.15
V-50	lb.	.49 /	.54
V-60	lb.	.37 /	.42
V-70	lb.	.68 /	.73
V-80	lb.	2.80 /	2.85
V-81	lb.	2.90 /	2.95
Permyl A	lb.	.45 /	.57
Stabelan 110, 120	lb.	.65 /	.78
115, HR paste	lb.	.85 /	.95
E	lb.	1.35 /	1.50
HR-50	lb.	.75 /	.90
HR liquid	lb.	.65 /	.75
Powder	lb.	.95 /	1.05
XL	lb.	.55 /	.65
Staflex QMXA	lb.	.70	
50% in DOP	lb.	.52	
OY	lb.	1.00 /	1.20
Stayrite #10	lb.	.33 /	.37
#15	lb.	.54 /	.57
#20	lb.	.38 /	.42
#22	lb.	1.32 /	1.34
#25	lb.	.36 /	.40
#70, 75, 80, 90	lb.	.69 /	.70
#229	lb.	.47 /	.50
P-10	lb.	.40 /	.44
Thermolite 12	lb.	2.00 /	2.25
13	lb.	3.10 /	3.78
15	lb.	4.13	
17	lb.	2.45 /	2.75
20	lb.	2.95 /	3.25
39	lb.	2.75 /	3.25
91	lb.	3.00	
Vanstay C-73 S	lb.	.63 /	.65
HT	lb.	.90 /	.92
L	lb.	.33 /	.35
LN	lb.	.98 /	1.00
R	lb.	.70 /	.72
Z	lb.	.67 /	.69

Wetting Agents

Advawet 212	lb.	.45 /	.50
Merix Wash Concentrate	lb.	2.59 /	3.69
Poly-lube No. 4	gl.	1.45 /	1.94